U.S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

Public Roads

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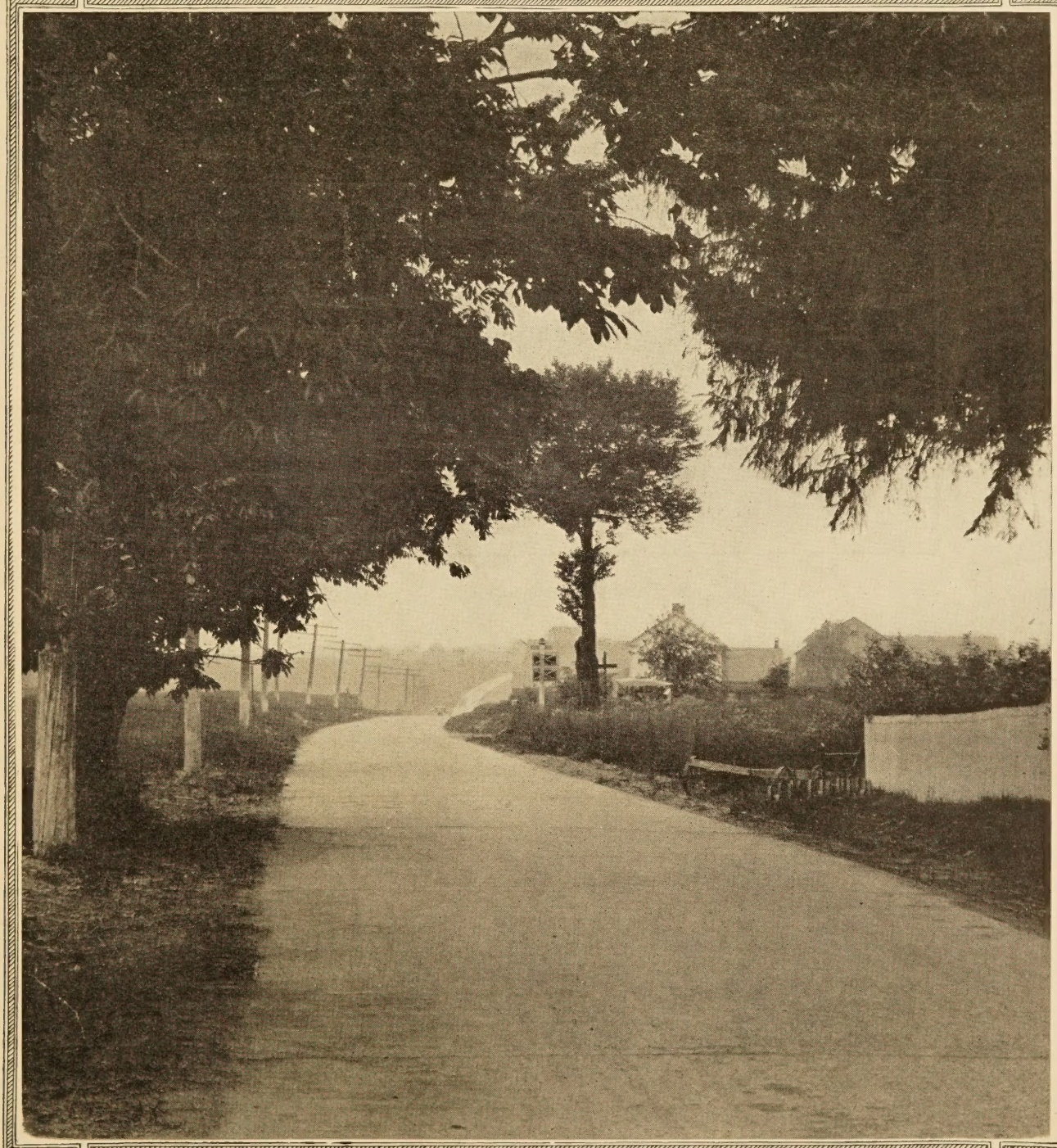

PENNSYLVANIA FEDERAL-AID PROJECT NO. 21. A REINFORCED CONCRETE ROAD NEAR READING

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U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

PUBLIC ROADS

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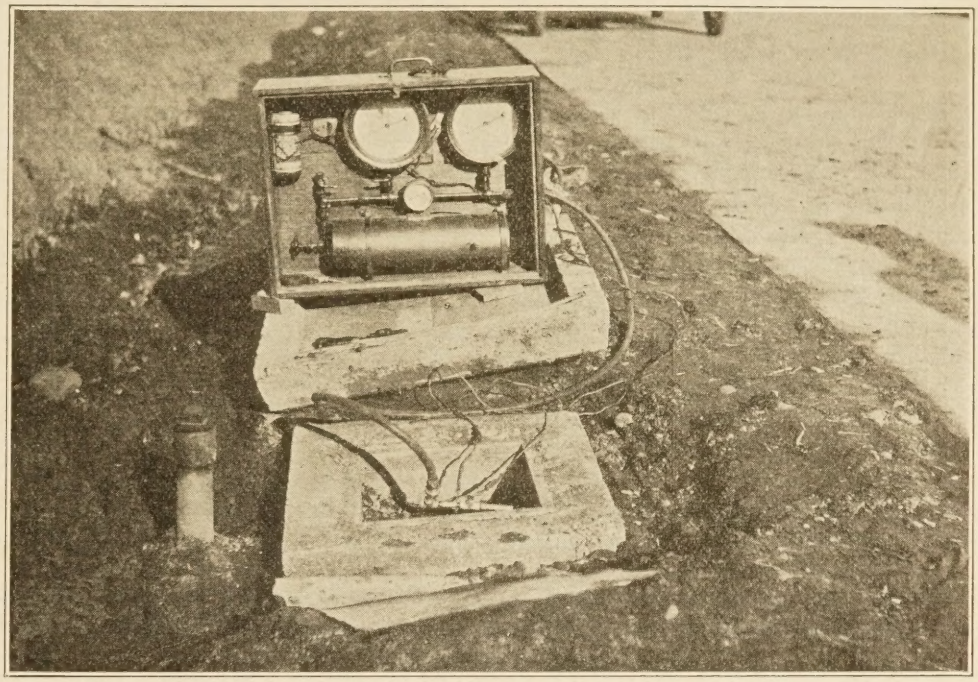
SOIL PRESSURE CELL MEASURES ACCURATELY TO TENTH OF POUND

By A. T. GOLDBECK, Engineer of Tests, Bureau of Public Roads.

THE soil pressure cell referred to in this article was developed by the writer in collaboration with Mr. E. B. Smith, senior assistant testing engineer, and others connected with the laboratories of the Bureau of Public Roads.

Numerous applications of the device have been made in connection with the experimental work of the bureau, such as the determination of the distribution of concentrated loads through sand fills,[1] the measurement of the pressure of concrete against forms,[2] the measurement of the pressures transmitted through road surfaces to subgrades,[3] and the measurement of pressures exerted upon retaining walls.



GENERAL VIEW OF INDICATING APPARATUS, SHOWING HOSE CONNECTIONS TO THE SOIL PRESSURE CELLS BURIED UNDER A CONCRETE ROAD.

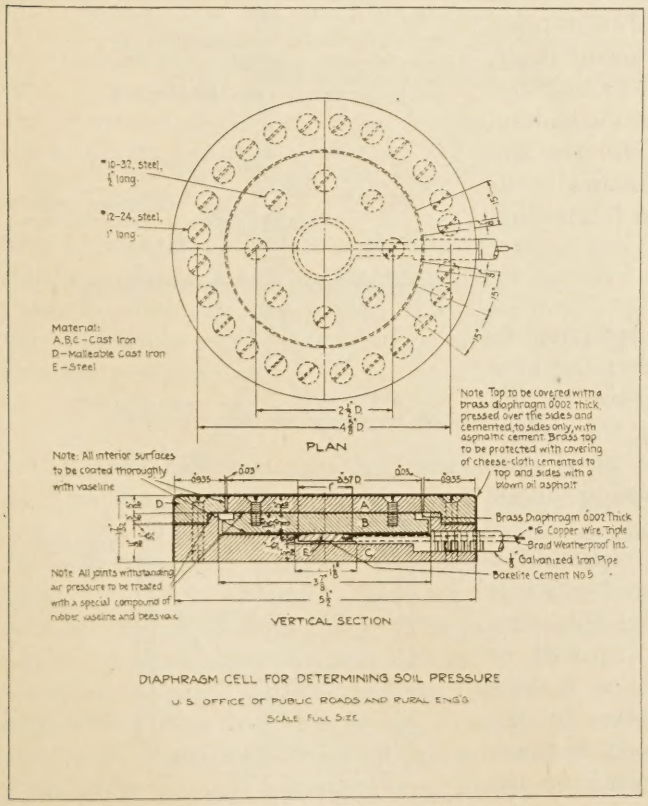


FIG. 1.—DIAPHRAGM CELL FOR DETERMINING SOIL PRESSURE.

At the suggestion of Mr. Charles H. Paul, assistant chief engineer of the Miami conservancy district, the bureau, in cooperation with the Miami conservancy district, conducted an extensive series of tests to determine the pressure exerted by a hydraulic fill, the tests being made in a standpipe 41 feet in height and 30 inches in diameter.[4] The device has since been adopted by the conservancy district to measure the pressures in their hydraulic fill dams, with results that follow very closely the typical curves resulting from the tests conducted by the bureau.[5] The results of these tests have demonstrated that material such as is used in the core of a hydraulic fill dam acts as a perfect fluid during the early stages of settlement, but that it loses its fluid qualities as consolidation proceeds.

In a paper on "Hydraulic Fill Dams" presented before the American Society of Civil Engineers on May 5, 1920, Mr. Allen Hazen refers to the use of this apparatus by the Miami conservancy district, and raises a question as to the accuracy of the instrument.

[1] The Distribution of Pressures through Earth Fills, Vol. XVII, 1917 Proceedings of A. S. T. M.
[2] Public Roads, Vol. 2, No. 23, March, 1920.
[3] Public Roads, Vol. 1, No. 12, April, 1919.
[4] Tests to Determine Pressures due to Hydraulic Fills, Engineering News-Record, Apr. 18, 1918, p. 758.
[5] Study of Pressures in Hydraulic Dam Cores, Engineering News-Record, Dec. 25, 1919.

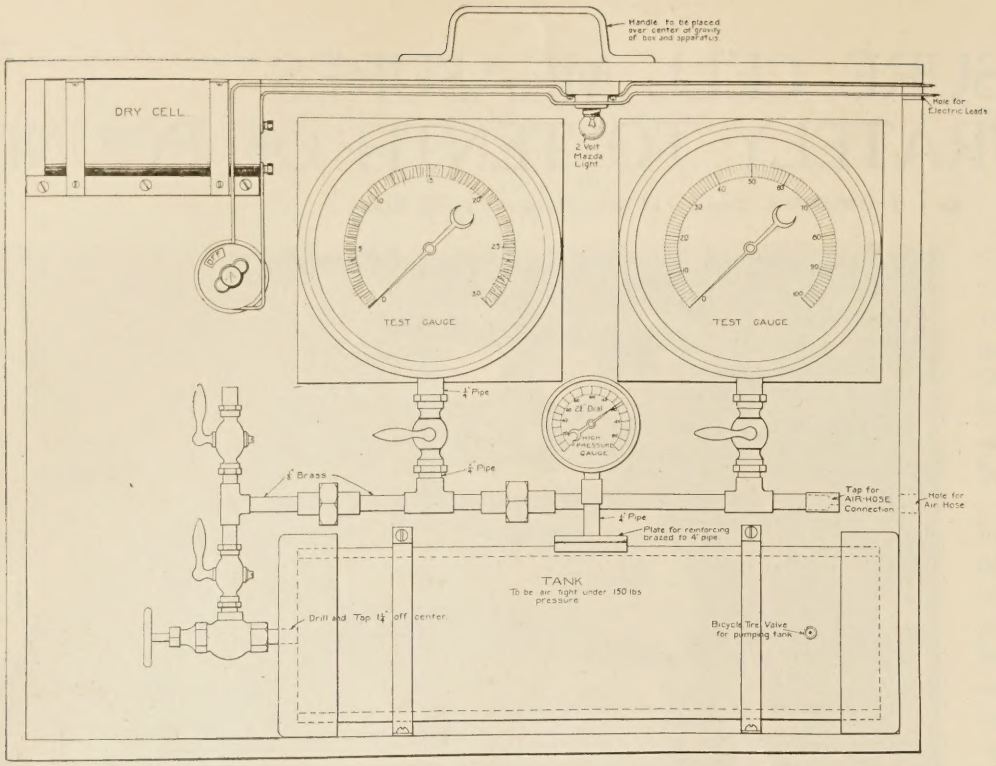


FIG. 2.—MOUNTING OF SOIL PRESSURE INDICATING APPARATUS FOR USE WITH DIAPHRAGM CELLS.

For the benefit of those who are not familiar with the soil pressure cell mentioned by Mr. Hazen, it may be well to describe the instrument and its applications before entering upon a description of the tests which confirm its accuracy.

The measurement of pressures transmitted through granular materials has always been a difficult one, primarily due to the fact that the measuring instrument must be capable of indicating such pressures with but an infinitesimal movement of the instrument itself The slightest motion of the weighing face disturbs the soil so that the pressure originally existing may be changed considerably at the instant the measurement is made. Any instrument to be successful for this purpose must be capable of measuring pressures with practically no motion and the soil pressure cell mentioned by Mr. Hazen fulfills this requirement.

PRINCIPLE OF ACTION.

The principle of its action may best be understood by referring to the cross section drawing shown in figure 1. The underlying idea of the device is to equilibrate the external earth pressure on the weighing face by means of internal air pressure, detecting the instant at which equilibration takes place through the breaking of an electrical circuit within the instrument and at that instant noting the air pressure required to overbalance the earth pressure.

Referring to figure 1, the soil-pressure cell is seen to consist of a cast-iron base *C*, 5½ inches in diameter, in the center of which is cemented a steel button *E*. Bakelite cement is used for this purpose for the double reason that it is an insulator as well as a cement. A thin brass diaphragm, as thin and flexible as a sheet of paper, is stretched across the base *C* and is held in place by the malleable cast-iron ring *D*. This diaphragm is clamped between two cast-iron disks, *A* and *B*, the lower disk, *B*, bearing on the button *E*. To protect the cell from moisture and to prevent the small annular space between ring *D* and disk *A* from becoming clogged with soil, the top of the cell is covered with a brass diaphragm like that between disks *A* and *B*, and the entire instrument is coated with a layer of cheesecloth cemented with a blown-oil asphalt. Blown oil is used for this purpose because of its comparative nonsusceptibility to temperature change. A galvanized-iron pipe connects the pressure cell with a small tank of compressed air which is placed in a portable indicating box containing pressure gauges for reading the air pressure within the cell. An insulated electric wire is led through this pipe to the button *E*, and the pipe itself furnishes the return circuit. A small dry cell and a miniature electric light are the only other electrical equipment required.

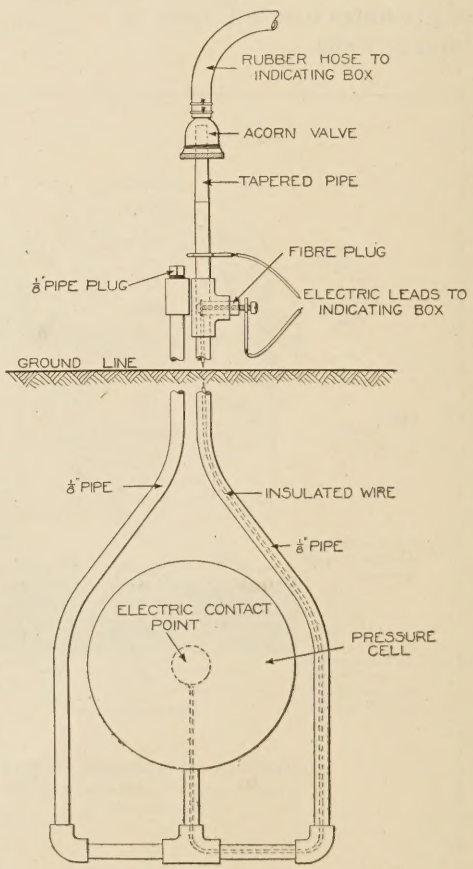


FIG. 3.—PIPE AND ELECTRICAL CONNECTIONS OF SOIL PRESSURE CELL.

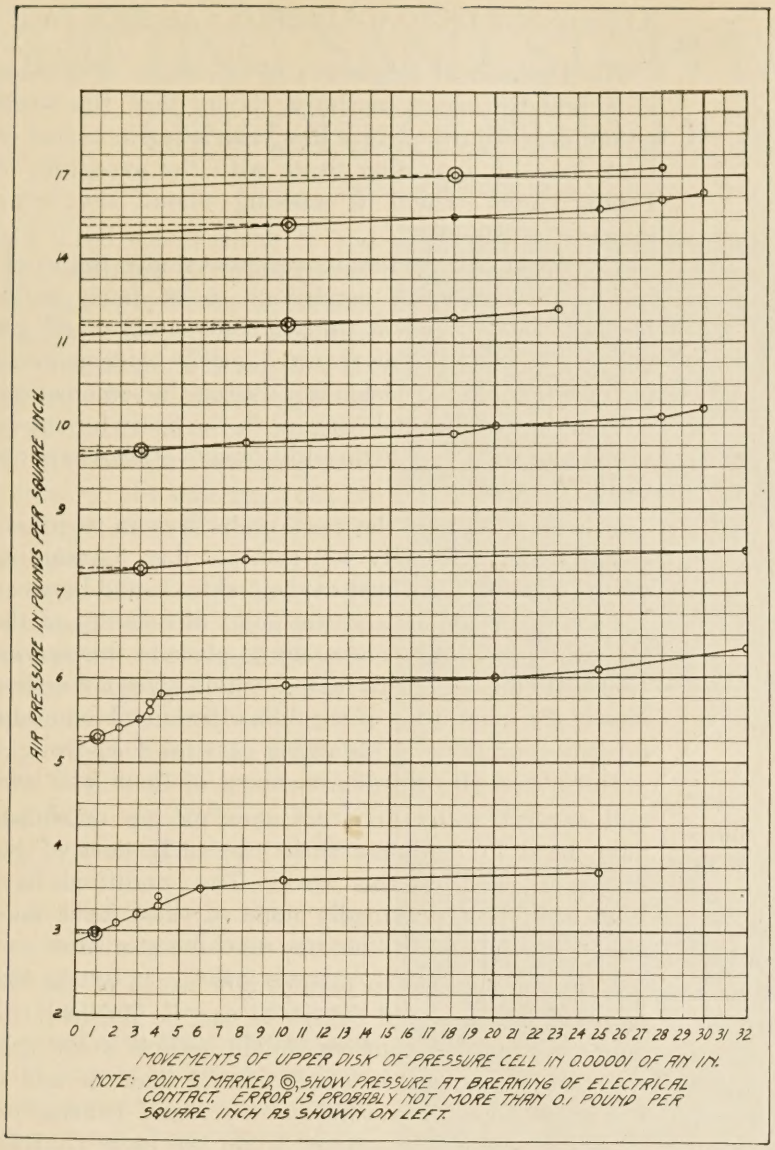


FIG. 4.—CURVES SHOWING MOVEMENT OF UPPER DISK OF SOIL PRESSURE CELL AFTER BREAKING ELECTRICAL CONTACT. CELLS BURIED IN 30-INCH MOIST SAND FILL.

The indicating box used with this pressure cell is shown in figure 2 and in the photograph on page 3. Control valves are also placed in the air line, which very delicately regulate the flow of air from the tank into the pressure cell.

METHOD OF MEASURING PRESSURES.

Let it be supposed that this instrument is to be used for measuring the pressures back of a retaining wall. The cells are first mounted securely against the wall with their weighing face placed toward the earth fill. It is, of course, necessary to mount the cells before the fill is in place. The pipe connections are led up to an accessible position, and if the cells are to remain in place and the readings continued over a long period, it is desirable to use a double pipe connection as shown in figure 3. Should any water collect in the pipes through condensation or leakage, this fact can be determined very readily merely by allowing the air to flow into one side of the pipe line, the other end being open. If water is present pressure will be indicated in the air line, due to the head of water. The mere fact that water is present, however, does not necessarily spoil the readings of the apparatus for, by the use of a double pipe line, the operator can cause the water to mount into one side of the line while he is taking his readings, which are thus not impaired by the presence of the water.

The operation in taking readings is to open the control valve on the pressure tank, thus allowing the air to flow very slowly into the pressure cell. As long as the cast-iron disk *B* in figure 1 is in contact with steel button *E*, this fact will be indicated by the burning of the small electric light in the indicating box. At the instant, however, that the air pressure within the cell slightly exceeds the soil pressure acting on the outside of the cell an exceedingly small movement of plate *B* takes place and it is raised out of contact with steel button *E;* the electric light is extinguished and the operator immediately reads the pressure on one of the test gauges in the indicating box. This records the air pressure within the cell, which necessarily equals the earth pressure acting on the cell. At the same instant the operator releases the air pressure within the cell, for at no time should he allow the air pressure to exceed the soil pressure by more than 0.1 pound per square inch, since by so doing the accuracy of future readings would be impaired.

It was several years before means could be devised for proving the accuracy of the results obtained where measurements of pressure of granular materials were made, although it was a comparatively easy matter to prove the accuracy of the instrument when used in liquids or semiliquids. The method pursued in checking these results for granular materials consisted in measuring the movement of disk *B* during the breaking of electrical contact. For this purpose a special set-up of the instrument was employed as shown in figure 5. The cell was placed flush with the surface of a reinforced concrete floor and 3 feet of sand was placed over the cell. In place of the wire ordinarily used in the pipe line leading to the cell a brass rod having an ivory tip bearing on the movable disk of the cell was employed. The other end of this rod bore on the plunger of an Ames dial reading movements of 0.0001 of an inch. Concentrated loads were placed on a bearing block resting on the sand fill over the cell and thus definite unit pressures were transmitted to the cell. Air was introduced and simultaneous readings of the air pressure in the cell and movements of the movable diaphragm were recorded at the breaking of electrical contact, and also

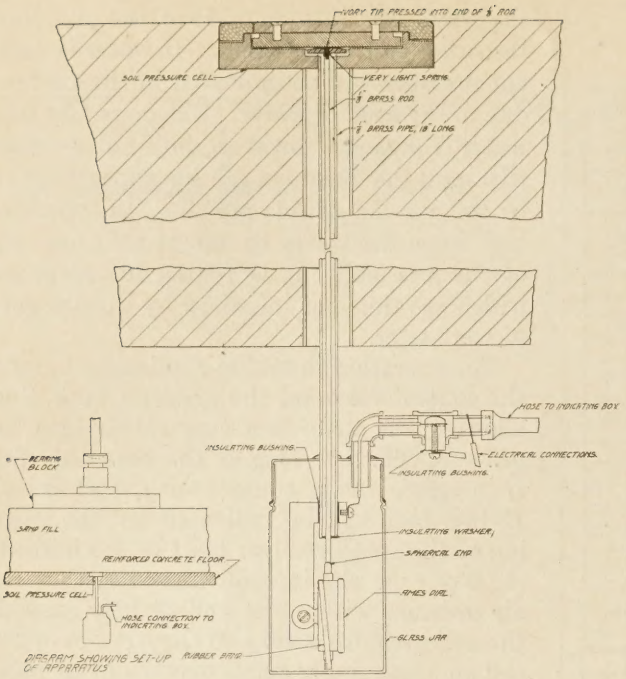


FIG. 5.—APPARATUS FOR MEASURING ERROR IN SOIL PRESSURE CELLS DUE TO SMALL MOVEMENT REQUIRED TO BREAK ELECTRICAL CONTACT.

after contact was broken. The curves in figure 4 show these simultaneous readings. The double circle shows how much movement took place in the instrument up to the point of breaking electrical contact, and the circles to the right of the double circle indicate the movements after the breaking of electrical contact. Before electrical contact is broken the soil pressure is counterbalanced by the internal air pressure plus whatever pressure exists on steel button *E*. After contact is broken within the cell the air pressure alone counterbalances the soil pressure and, therefore, it is known definitely how much increase in internal pressure is required to produce definite movements of the movable disk.

It will be noted that the movement required to break electrical contact for external pressures up to about 15 pounds per square inch is less than 0.0001 of an inch and for low pressures is only 0.00001 of an inch. It will also be noted from the curves that in general less than 0.1 of a pound per square inch increase in pressure is required in order to move the disk against the earth pressure 0.0001 inch or less. The small increase in pressure necessary to produce the exceedingly small movement of the diaphragm required in breaking electrical contact is the error of the instrument, and this is not more than 0.1 of a pound per square inch, since in general less than 0.0001 inch movement is required to break electrical contact.

The results of these tests have convinced us that the instrument gives thoroughly reliable results in granular materials, such as densely compacted sand, as well as in liquids and semiliquids. It has also been demonstrated that it is sufficiently rugged to withstand field conditions, and it might very readily be applied to obtain useful data on many types of construction.

ILLINOIS BUILDS ROADS DESPITE CAR SHORTAGE.

The Division of Highways of the State of Illinois in a bulletin issued recently claims that the work accomplished in the State this year is far in excess of that done by any other State with the exception of Pennsylvania, which is making about the same progress as Illinois.

The division considers its progress under the existing serious economic conditions to be fairly satisfactory, yet it believes that if contractors could get delivery of materials as required, easily twice as much pavement could have been laid during the same period, without any additional expense to the State for supervision and with very little additional overhead expense to the contractors.

It is asserted that the work under way in the State requires approximately 450 cars per day. Assuming that it takes 10 days for a car to make a round between the source of supply and the point of delivery of the material, it would be necessary to place in this service 4,500 cars for the entire season, which gives a startling idea of the magnitude of the difficulties involved under present conditions in obtaining cars for road work.

More than 40 contractors, many of them with two and several with three or more paving machines, have been in readiness since the early part of the season to carry on this work. The conditions have been such that practically none of them have been able to operate more than one machine at a time.

It is not possible to predict how much of the 350 miles of uncompleted contracts can be finished this year; but unless conditions should become worse than they are at present, it is anticipated that the end of the season will find most of the small contractors showing completed sections, while the large contractors will have a very substantial part of their work done. If the entire system can not be completed, there will at least be many stretches of completed pavement 15 to 20 miles in length and several from 70 to 100 miles in length.

Where it is impossible to get materials for surfacing, the division is proceeding with grading work and the construction of small bridges and culverts. In many places there are heavy fills to make, which require at least a year's time for settlement before the pavement can be laid. This work, as well as the bridges in connection with the grading, is well underway. With the heavy grading completed, the State can proceed under better economic conditions, which must come sooner or later, to build continuous pavements, which otherwise would not be possible if it were necessary to delay the pavement work in order to permit grading to settle.

In view of these accomplishments the division feels that the progress made thus far this season is all that could be expected.

SHIFTING SAND STOPPED WITH OIL ON OREGON FEDERAL AID PROJECTS

By A. F. MORRIS, Highway Engineer, U. S. Bureau of Public Roads.

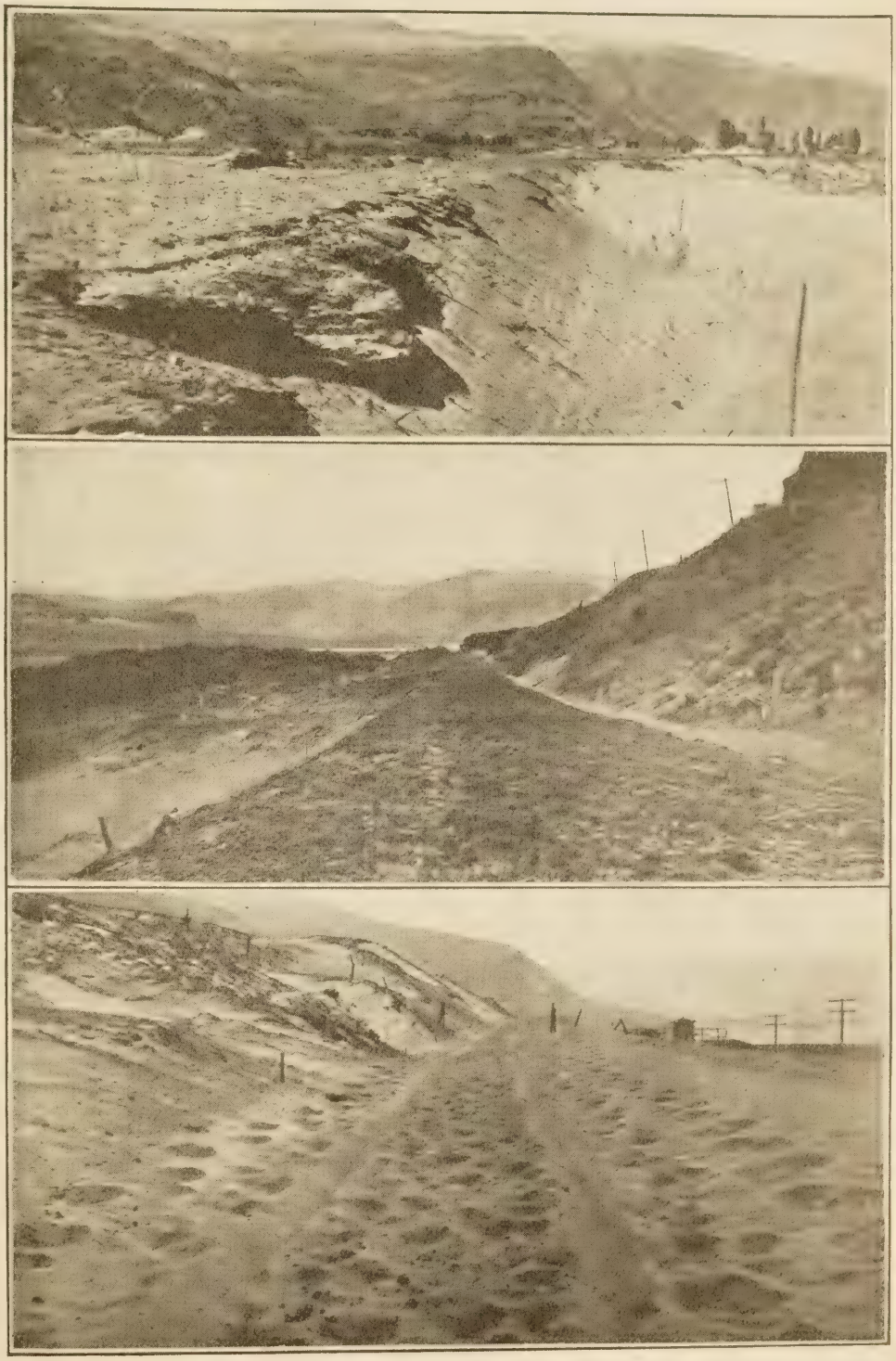
IN THE construction of the Columbia River Highway from Pendleton in eastern Oregon to Astoria at the mouth of the Columbia River, the engineers of the State highway department have encountered more unusual engineering difficulties to the mile than can be found on any other road in the Northwest.

From The Dalles to Astoria the road has now been graded and paved over practically the entire length and has become nationally famous as a scenic highway. Nearly 17 miles of this section of the road extending from The Dalles to Mosier has been constructed with Federal aid.

At The Dalles occurs a very marked change in the nature of the country. Down the river to the west the hillsides are covered with trees, shrubs, and wild flowers and in the ravines crystal-clear streams of sparkling water from the melting snows of the Cascades tumble over the cliffs in beautiful waterfalls.

To the east, along the river is a barren waste of sand and rocky, treeless slopes, while back from the river for miles and miles on both sides extend vast wheat fields. As most of the population of the country is located on this plateau the early roads naturally were constructed there, with short connecting roads from the main east and west highways, through convenient intersecting canyons, to the shipping points on the railroad which followed a water grade along the river.

The location of these early roads was justified by the



USE OF OIL ON ROADS TO CONTROL SHIFTING SAND. TOP—THE EFFECT OF WIND ACTION ON UNPROTECTED FILL SLOPES AT BLALOCK, IN GILLIAM COUNTY, OREG., ON FEDERAL-AID PROJECT NO. 24. CENTER—NEWLY GRADED SECTION OF FEDERAL-AID PROJECT NO. 37, NEAR CELILO, WASCO COUNTY, OREG., COVERED WITH STRAW AND STABLE MANURE. BOTTOM—NEWLY GRADED SECTION OF FEDERAL-AID PROJECT NO. 25, AT SHERMAN, OREG., BEFORE OILING. NOTE THE DEEP RUTS THROUGH THE SAND. IN THE UPPER LEFT OF THE PICTURE IS SHOWN A PORTION OF THE SAND HILL WHICH WAS OILED BY THE RAILROAD COMPANY.

OILING RIG ON FEDERAL-AID PROJECT NO. 25, AT DAY, SHERMAN COUNTY, OREG., IDLE FROM LACK OF OIL.

existing conditions. They best served the local needs, and through traffic, before the day of motor vehicles, had not become a governing factor in highway location; but when the choice of a route for the eastward extension of the Columbia River Highway was made, the matter of grades and alignment had become of major importance. It was, therefore, decided to continue the water grade up the Columbia and overcome the many obstacles to be encountered in such ways as could be devised.

FIGHTING THE SAND DUNES.

For years the railroad company has fought the sand dunes along its line. The Columbia River each year brings down deposits of sand and silt at the time of high water, which occurs in the month of June, when tributaries are swollen by melting snows. When the waters recede and the flow of the stream becomes normal, these sands are left exposed, to be picked up by the winds which blow almost constantly during the summer months, generally upstream, depositing it in sand dunes similar to those found along the ocean beach.

These dunes are constantly shifting and various means have been tried to keep them off the tracks. Low wooden barriers, similar to snow fences, were tried to deflect the sand, and a force of men was employed to clear the track with shovels. These sand fences proved inefficient and other means were tried with but little effect until it was proposed to sprinkle the tracks and near-by dunes with crude oil. This treatment has proved entirely satisfactory, and has completely stopped the movement except where the oiled surface has broken up or new dunes have been formed by sand deposited from distant points. To one unacquainted with them it is difficult to realize the force of the winds which even carry sand from the opposite side of the river, in places a mile away, so that new dunes are constantly being formed, which creep along with the wind until stopped by further applications of oil.

Fifty-three miles of the new highway from The Dalles eastward through this difficult country is comprised in five Federal-aid projects. One short section of 2 miles from The Dalles to Big Eddy is a bituminous concrete road and is entirely completed. The rest of the mileage which is now under construction will be graded only under the present contracts. The total estimated cost of the 53 miles is nearly $1,000,000, half of which will be paid by the Federal Government.

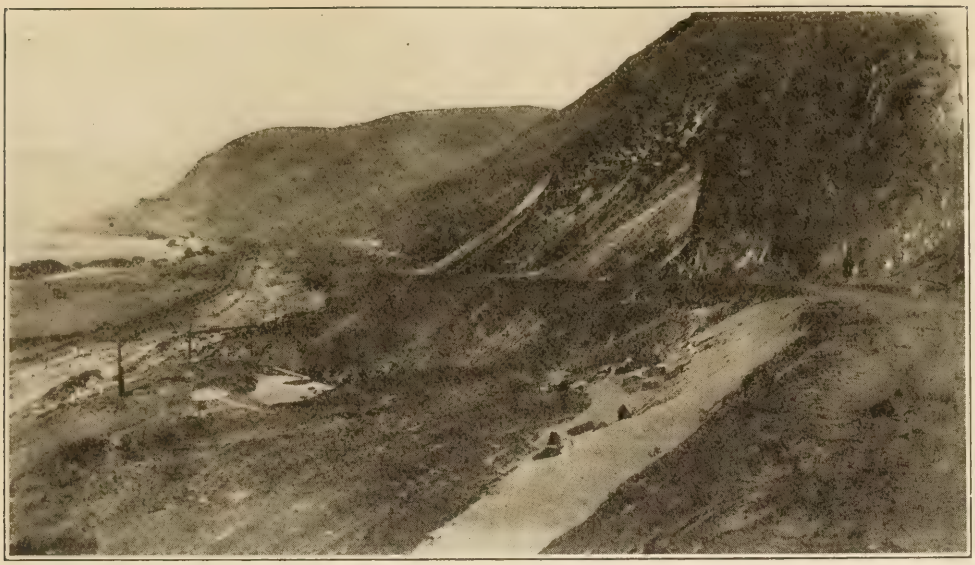
In constructing the new highway it has been necessary to cut through the banks of sand oiled by the railroad company, as well as many new banks which had not been oiled by the railroad forces. In other places, where there are no sand dunes, the soil consists of a volcanic ash as light and fine as flour. As fast as cuts are opened up and fills made in this light soil the wind cuts away the banks and whips out the fill slopes, and sand dunes creep into rock cuts, completely blocking the road.

USE OF OIL IS EFFECTIVE.

To stop the depredations of this mischievous wind some of the early work was covered with straw and stable manure, but while this method was fairly effective in protecting the fill slopes and the roadbed it did not afford the necessary protection to the cut slopes, nor did it stop the smothering inroads of the dunes in the cuts.

Half measures failing it has since been decided to adopt the tactics of the railroad company and oil the slopes and shifting sands as far as possible on each side of the road.

The equipment which is used to spray the crude oil consists of two supply tanks or drums, in which the oil is carried from the storage tank at the railroad siding, and a tractor which draws the oiling rig and supplies the steam through a hose to the compressor tanks, which are carried on a trailer. The oil is heated by the steam and is forced through a hose with a nozzle consisting of a short piece of half-inch pipe. The steam atomizes the oil and sends it in a fine spray for 100 feet or more, depending on whether the spray is projected in the direction of the wind or against it.



OILED SLOPES IN CUT AND FILL ON OREGON FEDERAL-AID PROJECT NO. 25, NEAR RUFUS, SHERMAN COUNTY.

Spraying is generally carried on in the direction of the wind for obvious reasons.

The accompanying photographs show the difficulties encountered and the means of overcoming them. The picture which shows the extent of the distribution of oil over the road side will be particularly interesting to eastern highway officials, who are having no end of trouble in getting the comparatively small quantities of bituminous materials they require for maintenance work. It may be added that the same conditions are seriously affecting the progress of this work. The shortage of cars has kept the supply of oil on hand always reduced to very small quantities, and the work is frequently halted by the total exhaustion of the supply. Indeed, the seriousness of the situation is such as to threaten the use of this most effective treatment entirely, and to force a return to the less adequate measures which have formerly been used, at least until the freight situation improves.

Where sufficient oil is used this means of controlling the sand movement is very effective and it is believed that the cost will not be excessive, though exact figures are not at this time obtainable.

MOTOR TRUCKS ON EASTERN FARMS.

Bulletin No. 919, just issued by the Department of Agriculture, dealing with the above subject, contains a great deal of information which will be interesting to highway engineers.

The bulletin is based on the experience with motor trucks of 753 farmers in the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland.

The farmers own trucks of all sizes and types from those of one-half ton to five tons capacity. The rated capacity of very few of the trucks is over 2 tons, however, and nearly half are of 1-ton size.

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Only 18 per cent of the farms are less than 5 miles from market, and nearly one-fourth are 20 miles or more.

In the opinion of the owners of these trucks the principal advantage of a motor truck is in saving time, and the principal disadvantage is "poor roads."

On the average it is reported that there are about eight weeks during the year when the roads are in such conditions on account of mud and snow, etc., that the trucks can not be used. Three-fourths of them usually travel on roads that are all or part dirt.

About one-fourth of the men have changed their markets, for at least a part of their produce, since purchasing trucks. For those who have changed their market, the average distance to the old market was 7 miles, and the average distance to the new market is 20 miles.

According to owners' estimates, each of the trucks travels an average of 3,820 miles per year and is used on 173 days per year.

Most of the owners of one-half and three-fourth ton trucks prefer pneumatic tires, the owners of the 1-ton trucks are about evenly divided in their preference, but most of the owners of trucks larger than 1 ton prefer solid tires.

Over two-thirds of these trucks had not been out of commission when needed for a single day during the year covered by the reports, and nearly the same proportion of the owners stated that they had not lost any appreciable time on account of motor and tire trouble, breakage, etc. However, about 1 truck in 30 had been out of commission 10 days or more.

Return loads are available according to the reports for only about one-fourth of the trips.

The average cost of operating the trucks of various sizes, including driver's wages, as well as the strictly operating charges, was 50.4 cents per ton-mile for the one-half-ton trucks, 33.8 cents per ton-mile for the three-fourth-ton trucks, 25.8 cents for the 1-ton trucks, 24.2 cents for the $1\frac{1}{4}$ and $1\frac{1}{2}$ ton class, and the 2-ton trucks cost 18.2 cents per ton-mile.

In the above data the drivers' wages included were 50 cents per hour, gasoline and oil cost from about 2 cents per mile for the one-half-ton truck to nearly 4 cents per mile for the 2-ton truck; tires cost 1.6 cents per mile for one-half-ton and 2.5 cents for 2-ton trucks.

Only one per cent of the whole number of replies gave the saving of expense as the principal advantage derived from the use of trucks instead of horses. Two per cent regarded the superior convenience of the truck as its principal advantage; 2 per cent thought that the ability to reach better markets was their crowning advantage; 3 per cent looked upon the saving of horses as the best reason for the use of the trucks; but nearly all, 91 per cent in fact, gave as the principal advantage "the saving of time."

BRITISH ROAD CONDITIONS AND HIGHWAY ADMINISTRATION

LOCAL GOVERNMENT in the British Isles differs so radically from the system of government under which Americans live that it is especially important that one who wishes to understand the methods of highway administration should first acquire a working knowledge of the system of government.

The American who interests himself in French highway methods is struck immediately by the close parallelism between the American and French governmental divisions. The national government of both countries is a federal government, a government of federated states or departments which, however, in matters of purely state importance have sharply defined powers of government reserved to them. The departments in turn include subordinate governments of the arrondissement, and the commun, which correspond very closely to the American counties and townships.

No such close parallelism appears when one comes to compare the governments of the British Isles and the United States. The greatest difference, perhaps, lies in the fact that there is no counterpart of the American State, unless the countries of England, Scotland, Ireland, and Wales may be so considered. Territorially, this comparison may serve, but from the standpoint of government there is no likeness whatever. Below the government of the Crown the largest subdivision of the government is the administrative county. These do not coincide territorially with the ancient counties, which, however are still the basis of the system of parliamentary representation. For practical purposes a number of these ancient counties have been combined to form larger administrative counties. Thus though there are in England and Wales 253 county areas, there are only 62 administrative counties. The latter correspond roughly in size and authority to the counties of the United States.

The administrative county is governed by an elected county council, which has jurisdiction over all places within its area with two exceptions; namely, county boroughs and the quarter sessions boroughs.

All boroughs, territorially, are parts of the administrative counties, but in matters of government only one of the three classes of boroughs is entirely subordinate to the administrative county. The three classes are known respectively as county boroughs, quarter sessions boroughs and noncounty boroughs. The distinction is largely one of population, though prior denomination as a county is one of the reasons for the independence of certain county boroughs.

The county boroughs are governed by a borough council, which is independent of the county council, and practically of coequal rank. In this respect they are similar to certain cities of the United States such as New York, Philadelphia, Baltimore, and St. Louis, which either are independent of county control, or occupy an entire county. The quarter-sessions boroughs govern themselves in certain matters, but in the control of highways are subordinate to the county. The third class of boroughs, the smallest ones, known as noncounty boroughs, are in all things subordinate to the administrative county, and are "rated" or taxed for all county purposes.

The boroughs are urban centers. Before 1848 there was, outside of these municipal boroughs, no district government. In that year the whole of England and Wales (subsequently also, Scotland and Ireland) was divided into local government districts. These districts now constitute the prevailing subdivision. They are either urban or rural. Urban districts include boroughs and places which were formerly under the jurisdiction of local boards or improvement commissioners; and it follows therefore that the borough councils of county boroughs have the powers and duties of urban district councils as well as those of county councils. The closest American parallel to these districts whether urban or rural are the New England townships.

The parish, originally a subdivision of the church government, now constitutes also the smallest subdivision of the government of the State. By the act of 1894 it is provided that parishes with a population exceeding 300 must elect a parish council. If it has a population of 100 or upward, the county council is bound to order the election of a parish council if the annual parish meeting so resolves. Where there is no parish council its powers are exercised by the parish meeting itself. Two or more parishes may be grouped under a common parish council by order of the county council, if the parish meetings of each parish consent. An annual parish meeting must be held within seven days before or after March 25; and, if there is no parish council, there must be at least one other parish meeting in the year. No American governmental subdivision compares closely with these parishes; though the parishes of South Carolina have a similar origin, and somewhat similar functions. In urban districts separate parish councils are not elected, but most of the powers of the parish council may be conferred on the district council, and in cases where the parish and urban district are conterminous, all the powers of the

parish council belong to the district council. One body may, therefore, in some cases, exercise the powers of the county council, the district council, and the parish council, but in most rural districts the three coexist with separate powers.

CLASSIFICATION OF ROADS.

All roads in England and Wales outside of London and county boroughs are at present classified roughly as—

1. Main roads, which may be situated in noncounty boroughs, urban districts, or rural districts, and
2. Roads other than main roads (generally called "District roads") in noncounty boroughs, urban districts, and rural districts.

In county boroughs and in London roads are not subdivided as between "main" and "district" roads.

In Scotland the classification is—

1. Roads in urban areas, cities, and burghs.
2. Rural roads.

The designation "main roads" does not necessarily mean that such roads are "important roads," but merely that the cost of maintenance is paid for out of county "rates" or taxes which are levied not only on rural districts, but also on the noncounty boroughs and urban districts in the county. Most main roads are those which were formerly turnpikes, but any road can be declared to be a main road by the county council on the application of a district council. In similar manner any main road may be "dismained," in which case it reverts to the status of a district road.

In reality it will be seen that there is at present in the British Isles no classification of roads upon the basis of importance. The classification as between "main" and "district" roads is merely a division upon the basis of control.

However, the newly created roads department of the ministry of transport is now engaged in acquiring from the various governmental subdivision the necessary data as to the character of the roads within their respective limits upon which a true "importance classification" will be based. According to the circular of the ministry of transport "the classification is to be made on the basis of the relative importance of the various highways for general traffic purposes, and regard will be had to the consideration whether a road proposed to be classified is an important arterial route for through traffic or possesses more than local importance." The roads will be divided into three classes designated, first class, second class, and third class. No precise definition can yet be laid down as to the roads which will be included in the respective classes, but it is stated that streets in county boroughs will not be considered for classification as first or second class. After the basic data has been acquired from the counties and districts, traffic censuses will be taken at points designated by the ministry, and upon the basis of this data and the recommendation of local officials the final classification will be determined by the ministry.

ADMINISTRATION OF HIGHWAYS.

Prior to 1909 there was no national agency empowered to exercise control over the highways of the British Isles. In that year the road board, a national agency, was constituted and empowered to assist the local authorities in the construction of roads with grants from the national treasury. The particular projects to be assisted were left to the discretion of the road board, as was also the amount of the Government contribution, except that the act creating the board expressly prohibited the granting of national funds for maintenance.

In its first report the board defined the character of works which might receive its assistance as follows:

1. Reconstruction of important roads, the condition of which is exceptionally bad and can not be improved without reconstruction.
2. Widening of important roads which are dangerously narrow.
3. Surfacing with granite, basalt, or other suitable material treated with tar or other bituminous compound by some approved method, main roads or important district roads which already have adequate foundations, especially those on or just beyond the outer fringe of large towns which have to carry a heavy traffic without aid from rates of the towns served by the roads.
4. Opening out of dangerous corners and alterations of dangerous curves.
5. Alteration, where possible at reasonable cost, of steep and dangerous gradients.
6. Strengthening or reconditioning of weak bridges, which seriously limit the use of commercial transport or roads of first-class importance.
7. Construction of new by-pass roads to avoid villages on main roads or important district roads where the conditions are exceptionally dangerous.
8. Acquisition in urgent cases where building is imminent of vacant land required for future widening of roads, especially in urban or suburban areas.

PROCEDURE TO OBTAIN NATIONAL AID.

Local authorities desiring grants of national funds for road work in contemplation were required to submit to the road board a general statement indicating the works for which assistance was desired. The statement was not usually treated as a formal application, but was followed by an interview between the board and representatives of the county council, at which more or less definite arrangements as to the

amount of the grant were decided upon. The county council were then required to submit detailed plans, specifications, and estimates, upon the receipt of which the road board submitted the case to the treasury for sanction, and made formal announcement of the grant. The construction when it was finally begun was subject to the approval of the road board.

In addition to this work in connection with the supervision of nationally aided construction, the road board, during the 10 years of its existence as a separate body, also undertook other helpful works, such as the standardization of the sizes of broken stone, and the operation of a testing laboratory for bituminous and nonbituminous construction materials.

In 1919 all the powers of the road board were transferred to the newly created ministry of transport, which was also empowered and directed to authorize the expenditure of national funds for maintenance purposes. The procedure to be followed in the granting of national funds is apparently unchanged.

LOCAL ROAD ADMINISTRATION.

England and Wales.—While the national authority, which is now the ministry of transport, exercises supervision over the construction and maintenance of roads upon which national funds are expended the actual work of construction or maintenance is performed under the direction of the county councils; and, indeed, the immediate control of all road work in the British Isles is vested in local authorities.

The "main" roads, previously defined, are paid for out of county taxes, and in general are constructed and maintained by the county councils, but it does not always follow that the actual work is performed by county officials. Some main roads in urban areas, usually called "claimed urbans" are main roads which the urban district authority has claimed under statutory power to maintain by its own staff, charging the cost against the county council. These are roads which existed, as main roads (of which half the cost was then paid out of county taxes), in urban areas, before the passage of the local government act of 1888.

Other main roads in urban areas and also some main roads in rural districts are maintained by the district councils by arrangement with the county councils. There is no uniform policy or system throughout the country, the local authorities concerned having been allowed to settle the matter according to their local circumstances and views.

Broadly speaking, however, most main roads, except:

1. Main roads in claimed urbans,

2. Main roads in some counties, such as Yorkshire (West Riding), in which the work of maintaining the main roads is generally left to district councils subject to some general supervision by the county surveyor, and

3. Some main roads in large urban areas are maintained not only at the cost of the counties but also directly by the county surveyor and the staff of the county council.

District roads are maintained by the council of the borough, urban district, or rural district in which they are situated, payment therefor being generally made out of taxes locally levied, with assistance in some few cases of payments by county councils out of county rates.

Highways in county boroughs are maintained by the municipal authority out of local taxes; and roads and streets in the city of London are maintained by the Corporation of London. In the administrative county of London the work is under the supervision of 28 metropolitan borough councils, each of which has a borough surveyor and staff. The cost of maintenance in each borough is paid for out of rates levied exclusively upon the borough concerned.

Scotland.—In Scotland the sytem of road administration as regards rural roads is more uniform than in England and Wales.

Roads in urban areas, cities, and burghs are maintained by the municipal authorities of these areas exclusively out of local rates.

Rural roads are maintained in one or two counties by the county council, but in most counties by district committees of the county council. These district committees, although their aggregate expenditure is subject to the general financial control of the county council through a statutory committee known as the county road board, are entirely independent of each other and free from any interference or control from the county council in the practical conduct of their work. Each committee has a surveyor who looks after the roads in its district, and the cost of maintainance is raised by rates levied exclusively upon the taxpayers of the district.

For all practical purposes, therefore, districts are treated as though they were counties, and in Scotland, where many counties are very large and sparsely peopled, there is a good deal to be said for the division of the county into districts. The Scottish system has this advantage over the English system—that all roads in a district are under one authority, who can regulate their expenditure on each road according to its importance, and adjust their annual expenditure more easily. It has all the disadvantages which everywhere accompany the subdivision of road authority into small units.

Ireland.—The system of road maintenance in Ireland differs from that in operation in England and Scotland. Outside urban districts, the roads are maintained by the county surveyor, who is employed by the county council. Rural districts do not have a separate highway surveyor or highway staff, but they have joint control with the county council over

expenditures. All expenditures on roads in a given rural district, however important the road may be, must be proposed in the first case, by the rural district council, and then confirmed by the county council. If the rural council is not willing to propose the expenditure the county council can not authorize its surveyor to spend the money. This system of dual control is a great obstacle in the way of the improvement and proper maintenance of roads in Ireland.

SOURCES OF FUNDS.

Revenues to be expended solely by local authorities for the maintenance and repair of highways are derived from the following sources:

1. General or special district taxes levied upon the same basis as the poor-law rate, but with the difference that agricultural land, railways, canals, tithes, and tithe-rent charges are assessed at only one-quarter of their poor-rate valuation.
2. National contributions under the agricultural rates acts.
3. Subventions from the exchequer contribution account of one-half the salaries of the local government board.
4. The proceeds of any district property.

Funds of the third class named constitute the balance which remains in the Government grants to each county after the services to which it is applied are paid for. In 1888 when it was first established in its present form, this balance was understood to represent one-half of the cost of maintenance of main roads, but owing to gradual increases in the prior charges on the fund, the amount of the balance has decreased in all counties, and in at least one has entirely disappeared. The amount of the balance which remains varies, therefore, in different counties, amounting in a few cases to more than the total main-road expenditure, while in the majority of cases it is insufficient to pay 50 per cent of the cost of the main roads, and in one case no balance is available after the prior charges have been met. After these charges the total balance of this grant generally amounts to a sum slightly exceeding 1,250,000 pounds sterling, or in American currency, at the rate of $4 to the pound sterling, $5,000,000.

County and burgh authorities in Scotland receive each year from the local taxation account, £35,000, or $140,000.

National contributions under the agricultural rates acts are not made specifically for roads, but each year some counties allocate sums out of these grants to the roads and bridges account. Sums so allotted are not defined and vary locally.

The general or special taxes levied upon land and property are levied impartially upon all land in the county or district, and bear with no greater severity upon abutting land than upon other land in the county or district.

SOURCES OF NATIONAL ROAD FUNDS.

The foregoing are the sources of funds for road purposes administered solely by local authorities. The funds dispensed by the road board in national grants to encourage construction were provided for by the development and road improvement funds act of 1909, and consisted of the revenues derived from a tax on motor fuel, and any surplus of license fees on carriages (including motor cars) beyond the yield of those fees in 1908. These were transferred annually from the exchequer to the road improvement fund, and, together with accretions due to interest and profit on investments, were devoted to the works aided by the road board. The receipts credited to the road improvement fund from the date of the passing of the act up to August, 1915, when, on account of the war, payments from the exchequer were suspended, amounted to £7,240,000 or (at $4 per pound sterling) $28,960,000. The interest payments continuing, the fund had grown by 1919 to £7,761,005.

During the war various Government departments made contributions to local authorities in Great Britain and Ireland on account of extraordinary damage to public roads by public traffic, the amount of which up to October 31, 1918, was £2,730,912, or approximately $10,924,000.

After the war, in 1919, a grant of £8,000,000 ($32,000,000) was voted by Parliament for the purpose of restoring roads in Great Britain damaged by extraordinary traffic during the war, and a sum of $1,200,000 was voted for a similar purpose in Ireland. These grants, however, were not specifically devoted to works of improvement.

NEW SOURCE OF FUNDS PROPOSED.

The motor fuel and carriage revenue payments from the exchequer having been suspended by war-time act, the road board, or as it now is, the roads department of the ministry of transport is left practically without continuing funds. Accordingly, in 1919, the matter of devising a scheme for the raising of national highway funds was referred to the departmental committee on the taxation and regulation of road vehicles. The problem is to raise an annual net revenue of approximately £7,000,000, which, after payment of the contemplated contributions by the Central Government toward the maintenance of first and second class roads will provide a sufficient sum to enable a substantial measure of new road construction and road improvement to be undertaken forthwith.

The report of the committee, published this year, favors the abolition of the motor fuel tax and substitution of a single revised tax on all motor vehicles, to be levied in accordance with the following scale:

RECOMMENDED SCALE OF MOTOR FEES.

Class of vehicle.	Suggested rate.	
	£. s. d.	Dollars.[1]
Motor cycles (up to and including 200 pounds weight)	1 10 0	6.00
Motor cycles (over 200 pounds weight)	3 0 0	12.00
Motor cycles (with trailer or side car)	4 0 0	16.00
Other motor 3-wheelers (except electrical or mechanical or other vehicles for invalids not exceeding 5 cwt. in weight)	4 0 0	16.00
Motor bath chairs and other motor vehicles for invalids, not exceeding 5 hundredweight	5 0	1.00
Private motor cars [2] (including 3-wheelers) weighing—		
7 hundredweight or over, unladen, per horsepower	1 0 0	4.00
With minimum of	6 0 0	24.00
Tram cars	15 0	3.00
Hackney vehicles:		
In metropolitan area and such other districts as ministry of transport may define—		
Seating capacity 1–5	15 0 0	60.00
Seating capacity 6–14	30 0 0	120.00
Seating capacity 15–20	45 0 0	180.00
Seating capacity 21–26	60 0 0	240.00
Seating capacity 27–32	72 0 0	288.00
Seating capacity over 32	84 0 0	336.00
In other districts—		
Seating capacity 1–5	12 0 0	48.00
Seating capacity 6–14	24 0 0	96.00
Seating capacity 15–20	36 0 0	144.00
Seating capacity 21–26	48 0 0	192.00
Seating capacity 27–32	60 0 0	240.00
Seating capacity over 32	70 0 0	280.00
Commercial goods vehicles (motor trucks) (including 3-wheelers weighing 7 cwt. or over unladen):		
Not exceeding 12 hundredweight unladen weight	10 0 0	40.00
Over 12 hundredweight but not over 1 ton unladen	16 0 0	64.00
Over 1 ton but not over 2 tons unladen	21 0 0	84.00
Over 2 tons but not over 3 tons unladen	25 0 0	100.00
Over 3 tons but not over 4 tons unladen	28 0 0	112.00
Over 4 tons unladen weight	30 0 0	120.00
Any of the foregoing with right to draw trailer	[3] 2 0 0	[3] 8.00
Other commercial and agricultural vehicles, motor tractors [4]	21 0 0	84.00
Road locomotives and agricultural engines: [4]		
Not over 8 tons unladen	25 0 0	100.00
Over 8 tons but not over 12 tons unladen	28 0 0	112.00
Over 12 tons unladen	30 0 0	120.00
Agricultural tractors used solely for agricultural hauling:		
Over 2½ tons but not over 5 tons unladen	6 0 0	24.00
Over 5 tons unladen	10 0 0	40.00

[1] Rate of exchange 1 pound sterling=$4.

[2] Electrically-propelled private cars to pay only the minimum of 6 pounds. Owners of private motor cars (not including motorcycles) who can show that the engine of their car was constructed prior to Jan. 1, 1913, to be entitled to rebate of 25 per cent of the tax.

[3] Additional.

[4] Including legally permitted trailers.

The committee has recommended that fees collected in accordance with the above schedule, as well as drivers' licenses and penalties for violation of the motor vehicle laws, less the costs of collection, be devoted to purposes of road construction and maintenance.

The objection to the tax on petrol has been that it did not cover the other liquid fuels, such as benzol, kerosene, paraffin, power alcohol, etc. A further point was that if it had been decided to go on with a fuel tax it would have been necessary to raise the rate from 6d. (10 cents) per gallon for pleasure vehicles to 1s. 3d. (25 cents), and the commercial tax from 3d. (5 cents) to 7d. (12 cents), or if a flat rate were preferred to 1s. (20 cents) all around.

Though the petrol tax will be abandoned, if the committee's recommendation is carried out, and though it is also recommended that the new tax be the sole tax collectable, replacing all local vehicle taxes, there is nevertheless a pronounced feeling, especially among motorists, that the rates proposed are excessive, and there is likely to be a good deal of opposition to it. Compared with prevailing American license fees, the tax proposed for automobiles does seem excessive, but the rates for motor trucks appear rather moderate.

NATURE OF LOCAL ADMINISTRATIVE CONTROL.

As the county councils administer the main roads of the country it may suffice to describe the nature of the administrative control exercised by these bodies as typical of the character of local highway administration in general.

A county council is composed of ordinary members elected for three years and aldermen chosen for six years by the whole council. The number of councillors was originally left to be fixed by the local government board, as were the electoral divisions, which were intended to be as nearly as possible equal in population; and both the number of members and the electoral divisions may be varied from time to time by the board on representation of the council.

The aldermen are one-third of the number of councillors, and apart from their longer term of office they have no special privileges. The council elects a chairman and vice chairman who hold office for one year, but are usually reelected. The ordinary council meets only some four times a year, and so conducts its business chiefly by committees. These have charge of the administrative work and direct the permanent officials. The business of the council is to determine questions of policy and control the actions of committees. But inasmuch as the council meets ordinarialy only once a quarter, it is customary to delegate to the committees full powers to act in particular matters in order to expedite business. However, the power to levy taxes or raise loans can not be so delegated.

Under the administrative control of the committees the county business is handled by a group of permanent officials, among whom are the highway officials, known as "surveyors," headed by the county surveyor, who receives about $2,500 per year. He is assisted by a deputy engineer, at about $2,000 per year, an engineering assistant at $1,500, and three or more district surveyors, who receive about $1,500 per year. These men are responsible for the engineering features of construction and maintenance.

The contract system for building and maintenance is almost entirely done away with, the work being carried out by county forces.

Convict labor is not employed on road work, and the only measure resembling the system of convict labor as it obtains in the United States is the use of so-called "casuals" or tramps who stay over night at workhouses, and are required in the morning before leaving, to break a certain quantity of stone for road purposes. This stone is sold by the workhouse authorities, and yields somewhat more than the expenditure upon the "casuals."

MILEAGE OF ROAD AND ROAD EXPENDITURES.

According to the most recent reports, those for 1913–14, there are 152,085 miles of road of all classes in England and Wales; 24,908 miles in Scotland, and 59,150 miles in Ireland.

In England and Wales, and Scotland, the reported mileage is divided into classes according to administration as follows:

ENGLAND AND WALES.

Class of road:	Mileage.
Main roads—	
Urban districts and noncounty boroughs	4,366
Rural districts	23,833
Other roads—	
Urban districts	11,871
Noncounty boroughs	4,867
Rural districts	94,628
Roads in county boroughs	10,304
Roads in corporation of London	48
Roads in metropolitan boroughs	2,168
Total in England and Wales	152,085

SCOTLAND.

	Mileage.
Roads under county councils	22,664
Roads in burghs	2,244
Total in Scotland	24,908

No classification of the mileage of roads in Ireland is available.

Expenditures for maintenance and improvements upon the whole mileage of roads in the Islands, from 1909 to 1918, as far as these data are available, are tabulated in the following table. It should be noted that all works of maintenance are conducted by the local authorities, who also carry on certain work, such as resurfacing, widening, etc., which are classed as improvements, and may be regarded as construction. In addition to the works of improvement conducted by the local authorities with local funds, there are the works carried on with the assistance of road board grants, the character of which has already been described.

STATEMENT OF ROAD MILEAGE AND REVENUES, BY YEARS.

Year.	Mileage.			Expenditures for improvements.						Expenditures for maintenance by local authorities.		
				[5] By Imperial Government.			By local authorities.					
	England and Wales.	Scotland.	Ireland.	England and Wales.	Scotland.	Ireland.	England and Wales.	Scotland.	Ireland.	England and Wales.	Scotland.	Ireland.
1	2	3	4	5	6	7	8	9	10	11	12	13
1910	150,918	24,831	58,334				£416,489	See col. 12	See col. 13	[1] £14,162,641	[2] £1,193,653	[2] £1,068,366
1911	150,671	24,816	58,334	£8,420			585,041	do	do	[1] 14,612,962	[2] 1,242,755	[4] 1,080,794
1912	151,472	24,816	58,334	186,059	£40,931	£18,848	552,936	do	do	[1] 14,724,439	[2] 1,305,003	[4] 1,144,711
1913	151,920	24,859	58,334	308,031	45,987	24,265	486,565	do	do	[1] 15,382,185	[2] 1,347,491	[4] 1,163,878
1914	152,085	24,908	58,334	544,608	64,742	30,363	562,598	do	do	[1] 16,139,571	[2] 1,413,383	[4] 1,178,649
1915	[3]	24,908	59,150	731,954	91,937	62,844	See col. 11	do	do	[2] 16,283,300	[2] 1,484,147	[4] 1,209,206
1916	[3]	[3]	[3]	404,759	50,748	43,650	do	do	do	[2] 15,566,170	[2] 1,368,222	[4] 1,199,712
1917	[3]	[3]	[3]	256,771	33,107	28,758			do	[3]	[3]	[4] 1,181,807
1918				166,302	22,845	20,307				[3]	[3]	[3]
1919				166,600	20,911	31,851				[3]	[3]	[3]

[1] Includes expenditures for cleaning and loan charges, but not for improvements.
[2] Includes expenditures for improvements and loan charges.
[3] Not reported.
[4] Includes expenditures for improvements and cleaning, but not loan charges.
[5] Includes Road Board grants paid only.

NOTE.—Up to Oct. 31, 1918, a total expenditure of £2,730,913 had been authorized by Government departments other than the Road Board, largely to repair damage to roads due to war traffic.

CHARACTER OF ROAD CONSTRUCTION AND MAINTENANCE.

British roads outside of incorporated cities and towns are generally surfaced with water-bound or bituminous macadam. Surface treated water-bound macadam is also in very general use for ordinary rural roads. For heavy traffic arteries the practice in the past has been to resort to granite blocks or "setts," or wood blocks on concrete foundations. The granite "setts" are no longer desired, on account of the roughness of the surface, and wood blocks are reported as very expensive and difficult to obtain. Water-bound macadam has proved unsatisfactory under motor traffic; and as a result British road authorities are conducting a number of experiments, dealing largely with various types of bituminous roads, in the hope of finding a suitable surfacing material. Portland cement concrete has not so far taken anything like the prominent place it does in this country. However, the subject of concrete roads was one of those most thoroughly discussed at the recent Roads and Transport Congress held in London in November, 1919, and apparently the concensus of opinion was in its favor, certainly for towns, "provided a surfacing material (of tar and granite chips) is used to render the roads suitable for horse traffic."

An interesting reflection of the present state of opinion in regard to concrete is contained in a recent clipping received from the Newcastle Evening Chronicle, as follows:

"Northumberland County Council has the distinction of being one of the first public bodies in England to adopt the ferro-concrete system of road making, a start having already been made on a stretch three quarters of a mile in length at Wideopen. The success of this initial step will be watched with much interest, because on it depends the extent to which this form of road making will ultimately be applied to the whole country. For the concrete road it is claimed that it is more durable, and more economical in the long run than others, and provides an excellent surface for all sorts of traffic. Of course in frosty weather a concrete road, like any other, would have to be 'gritted'."

Assuming the practice in the counties of Devon and Cornwall to be typical of the general practice through-

out the Islands, the average rural macadam roads are built 18 inches thick, including a Telford base. Main roads are built not less than 18 feet wide, and no grade crossings are permitted. Culverts and bridges are of stone or steel, the smaller ones frequently of vitrified clay.

Data on the costs of construction and maintenance are reported by a number of consuls, and are in fair agreement. For ordinary rural roads it is reported that 4½ inches of tar-macadam surface costs at present as high as $3.40 per square yard. Seven inches of water-bound macadam costs $2.15 per square yard. A 10-inch foundation of larger rocks costs $1.10 per square yard. A 4-inch concrete base costs approximately $1.50 per square yard. For very heavy traffic a surface of stone "setts" laid on a 9-inch concrete base will cost nearly $12 per square yard. A surface of Baltic red wood block on a 6-inch concrete base, costs at present prices over $13 per square yard. The prices quoted are furnished by the city engineer of Liverpool.

Maintenance figures quoted from the same authority vary from 30 cents per square yard for a granite-set pavement under heavy traffic to 9 cents per square yard for the same pavement under average city traffic. It is stated that the red wood surface will require an expenditure of 30 cents per square yard per year to keep it in condition; a pitch-macadam surface 14 cents and a water-bound macadam surface as high as 56 cents per square yard per year. It should be noted, however, that these prices probably apply to city conditions, and the city engineer states that they include cleaning as well as maintenance of the surface.

ROAD CONDITIONS AND TRAFFIC.

As elsewhere throughout the world wherever the effects of the war were felt the roads of the United Kingdom have seriously deteriorated since 1914, due to the cessation of proper maintenance and repair and the extraordinary development of highway transportation. To provide for the repair of roads damaged by war traffic several Government departments have extended grants of money to the various local authorities, but these have not approached in amount the large expenditure which will be required to restore the roads and fit them for the augmented traffic of the present day.

The conditions of rail transport are even more chaotic perhaps than in the United States. There is a shortage of freight cars and a depreciation generally of all rolling stock and road beds, to repair which it has already been necessary to effect one advance in rates, which is likely to be followed in the near future by another. As in the United States serious congestion of the railways and delays in transit have caused an enormous development in motor transport of merchandise, and road organizations similar to the "return loads bureaus" which sprung up here during the war are fostering the new highway traffic and bringing the truck owner into contact with prospective clients. The change in the system of taxation from a tax on fuel to what appears to be an exceptionally favorable tax per vehicle for motor trucks will undoubtedly further advance the use of the motor trucks.

As an example of the character of service furnished by the truck transport companies and the cost of such service the following extracts from the report of the American consul general at London may be of interest. The information is supplied by Messrs. Carter, Peterson & Co., one of the chief haulage contractors in or around London. "The figures given are based on cost and do not include the expenses of the selling department of a transportation business. The concern furnishing these figures is one for the distribution of various packages, the average weight being approximately 40 pounds. Transit is effected by road to local delivery offices situated in the various boroughs surrounding the City of London, and delivery effected thence to retail shops or direct to private houses. The zones covered by the Carter-Peterson service are, firstly, the area of London proper, and the residential suburbs surrounding it. The three zones surrounding it approximate to 30, 50, and 70 miles radius from the center of London. All point-to-point transfer services within the area are carried out by motor lorries, running to time-tables like passenger trains. The aim of this company is that one of its local collection vans should pass down each street in the area, at least once every day—consequently, the public are able, by exhibiting a card in the window, to attract the notice of the carman, who thus collects any traffic there may be for him." The cost information supplied is based on the costs of a 4-ton Leyland truck, adding a profit of 7 per cent. It is assumed that there will be constant work for the vehicle, providing full loads outward and inward, without overtime; the working day being 8 hours and the average speed of the vehicle 10 miles per hour. The rate of exchange from English currency has been taken as $4 to the pound sterling.

Cost per ton-mile, $0.083.
Load carried, 4 tons.
Nature of freight, general goods.
Kind of vehicle, 4-ton-gasoline-driven.
Depreciation, 15 per cent on capital outlay.
Maximum load, 4 tons.
Drivers' wages, $15.80 per week.
Total mileage, 60 miles per day.

In view of the impression that prevails in this country that the truck, as an agent of transportation, has an advantage over the railroads by virtue of its independence of labor troubles, it is interesting to note that in England a strike of motor-truck operatives last spring tied up practically all transportation by highway, and was settled only by granting an advance in wages amounting to about $1 per week.

Profiteer-ridden Americans may also find the consolation which is derived from company in misery, in the report of an alleged combine to control road-transport rates in England. An investigation conducted last February, however, by the central profiteering committee resulted in a Scotch verdict "not proven." The report of the committee points out that the importance of road transport as a factor in raising the cost of living lies in that it enters into the cost of production of every article of use or consumption. Indeed many commodities are carried by road five or six times before coming to the consumer. According to the report the cost of transportation in England has risen 300 per cent since 1914.

DENSITY OF TRAFFIC.

Some idea of the density of highway traffic and, consequently, of the highway problem which exists at the present time may be gleaned from the figures presented by the committee on taxation of road vehicles. According to the committee the numbers of vehicles of various classes in England and Wales at midsummer 1920 will be as estimated in the following table:

MOTOR VEHICLES IN ENGLAND AND WALES.

Class.	Number (summer of 1920).
Cycles	265,000
Private cars	210,000
Hackney vehicles	70,000
Commercial goods vehicles	100,000
Other commercial and agricultural vehicles	7,500
Total motor vehicles	652,500

The magazine "Modern Transport" publishes an estimate which agrees with the above only in the number of private cars. Its estimate of the total number of vehicles of all classes is only 311,000.

If the committee's estimate is correct there are in England and Wales 2.5 motor vehicles, excluding cycles, for each mile of road, as compared with the average density of 3.05 in the United States. If Modern Transport is nearer to the facts, then there are only 2 motor vehicles for each mile of road, including cycles. Figures supplied by the American Exporter which rate the number of motor vehicles in Great Britain at 255,000 are lower than either of the British estimates but conform more closely to the estimate published by Modern Transport.

WISCONSIN'S MAINTENANCE POLICY.

In planning the maintenance of the State trunk highway system the Wisconsin commission decided at the outset to install a thorough system of patrol maintenance, supplemented in practically all counties by small gangs for reconstruction and heavy repair work.

The commission did not advocate the promiscuous regrading of all roads on the system immediately. Those that could be maintained reasonably well by ordinary patrol maintenance methods were permitted to wait a year or more until the necessary funds were made available for this purpose.

Sections of the system that lacked drainage, cuts and fills that were dangerously narrow, dangerous turns, and surfaced roads that required additional shoulders and resurfacing received attention as early as possible in order to get the best results under the patrol system.

The additional 2,500 miles authorized by the legislature of 1919 has been selected by the legislative committee and the highway commission and will be handled in all ways the same as the original 5,000 miles were handled.

In certain sections of the State, especially in undeveloped portions of northern Wisconsin, there are portions of certain new trunk highways that will not be maintained for one or more seasons. The portion not to be maintained for 1920 amounts to about 300 miles, and in practically all cases there is no road that is fit to travel at the present time. As soon as a road has been laid out and is in reasonably fit condition for a patrolman to maintain, it will be taken over for maintenance,

The following specific policies have been put into effect:

1. The system lying in each county is divided into patrol sections, averaging from 6 to 8 miles in length.
2. A patrolman is engaged for each section, who devotes all his time to the work for the entire maintenance season, which is about seven months in northern counties and eight months in southern counties.
3. Patrolmen are paid a monthly salary sufficient to attract good men. The patrolman must furnish a satisfactory team and wagon, the county furnishing a light blade grader, road planer, plow, slip scraper, and other necessary tools.
4. The patrolman is responsible for the maintenance of his section, and where extra help is necessary to adequately maintain any particular section, it is furnished by the county, but the work is done under the direct supervision of the patrolman. The basic idea is to place responsibility "on one man only, the patrolman."
5. The patrolman reports daily and monthly to the county highway commissioner, showing the hours worked and their distribution. The monthly reports are forwarded to the division engineer's office by the county highway commissioner, and show the cost and distribution of both labor and material used on each section. These reports must be received by the county highway commissioner before the patrolman's salary will be paid.
6. Small gangs are organized in each county, equipped for the special work required, according to the type of road to be maintained; a gang for applying surface treatments; one for heavy blade grader work; one for scarifying and shaping up old gravel and macadam roads; one for resurfacing.

VALUABLE STUDY OF MOVEMENT OF CAPILLARY WATER IN SOIL

BULLETIN NO. 835, entitled "Capillary Movement of Soil Moisture," by Walter W. McLaughlin, senior irrigation engineer of the Bureau of Public Roads, has just been issued by the Department of Agriculture.

While it is written primarily from the standpoint of the irrigation engineer, the tests which it describes and the observations it records are of great interest to highway engineers as well.

Capillary attraction has for some time been recognized as a probable cause of the high moisture content of soils composing road subgrades under certain conditions, but unfortunately scientific knowledge of the movement of capillary water is exceedingly meager—so meager, in fact, as to provide no adequate basis for the development of measures of combating the conditions to which it gives rise.

The Division of Tests of the Bureau of Public Roads is at present engaged upon a series of tests to discover the sources of water found in actual subgrades, and to determine the effect of such water upon the bearing power of the soils. The methods adopted in making these tests were described in Public Roads, Vol. 2, No. 24, but, as yet, they have yielded no important results.

It is certain, however, that the careful observations recorded in this new bulletin by an engineer of the irrigation division of the Bureau of Public Roads will throw a great deal of light on many of the conditions observed in the collateral highway tests.

The tests described include observations of the movement of moisture under the two commonly existing conditions:

1. Where the source of the moisture is a body of free water.
2. Where the source of moisture is a body of moist soil, not connected with a body of free water.

MAKING THE TESTS.

The soils tested were packed in flumes; some open so as to allow evaporation to take place, others closed to prevent evaporation. One side of the flumes was of glass so as to permit the movement of the moisture to be observed.

The flumes were set horizontally, vertically, and at various angles with the horizontal, and in each position were packed with a number of representative soils varying from light sandy varieties to heavy clay. This arrangement provided for the study of the rate and extent of the capillary movement in columns of various types of soil under conditions designed respectively to eliminate the attraction of gravity as a factor, to include it as a counter attraction to the capillary force, and to include it as an assisting force.

In connection with the experiments, records were kept of the air temperature and the evaporation from a free-water surface.

The results of the tests of vertical soil columns confirm in the main the observations of other investigators of the vertical movement of capillary water. The observations indicate that the rate of movement in the lighter soils is more rapid for the first few hours and then slows down much quicker than in the heavy soils. In general, it was found that the lighter the soil the shorter would be the distance the moisture would move upward in a long period of time.

The horizontal capillary movement of moisture has not been studied to any great extent before. In respect to the rate of movement in the lighter and heavier soils the phenomena noted in the case of upward movement are exactly reversed when the movement is horizontal. The extent of the movement in the various soils, with one exception, was in inverse order to their moisture equivalents. The light soil with the lowest moisture equivalent showed the greatest movement of moisture while the heavy soil with the greatest moisture equivalent showed the least movement of moisture. The lighter soils used the greater total quantity of water in long periods of time and moved it farther in the horizontal direction than the heavier soils. These are the opposite of the conditions noted in connection with the vertical movement, and should be of particular interest to highway engineers, in view of the fact that the horizontal movement of water from road shoulders toward the center of the pavement must be fully as great as the upward movement of water from underground sources.

The phenomena noted in connection with the movement in flumes tilted at various angles to the horizontal combine the characteristics of the movement in the two cardinal directions as might be expected.

VALUE TO HIGHWAY ENGINEERS.

Among the observations of greatest significance to highway engineers are those which refer to the effect of temperature upon the movement of capillary water. The experiments indicate that a temperature of from 26° to 32° F. has a marked influence upon soil moisture other than the mere fact of freezing. A number of the horizontal flumes tested when the temperature was or recently had been below 30°, consistently showed greater percentages of moisture near the top of the flumes than near the bottom. Basicly the percentage of moisture in the top samples should be less than that

in samples from the bottom layers. In the first place gravity tends to draw the moisture to the lower layers. Secondly, evaporation tends further to reduce the moisture at and near the surface. Thus the laws of physics would indicate a lower percentage of moisture toward the top of the flume than near the bottom. There were, however, several instances where this relationship was interchanged, and more especially was this noticeable during the winter of 1916–17. When this interchanged relationship was observed so frequently during the spring of 1917 as to almost preclude the probability of error in sampling, it seemed evident that the unlooked-for distribution of moisture was the result of some natural condition. It soon became apparent that the top part of the flumes showed the greater percentage of moisture during only that part of the year when the air temperature was or recently had been below 30°. Looking back over the results of the preceding winter, the same condition was found. When these facts became evident it was so late in the season that there was no opportunity to prove the matter beyond a question of doubt. Before a definite conclusion can be drawn, therefore, additional experiments will have to be made. The covered flumes seemed to require a somewhat lower temperature to produce the condition than the open flumes. These observations are so suggestive as a possible explanation of the saturated condition of road subgrades in the spring of the year as to merit the fullest investigation by highway engineers.

The bulletin is now available for free distribution and all who are interested may obtain a copy by applying to the Chief of the Bureau of Public Roads.

MAINTENANCE ON ENGLISH ROADS.

During the year ending in March, 1920, maintenance upon the Essex, England, county main roads, aggregating 672 miles, cost the county authorities, according to the annual report of the county surveyor and recently reported in the "Surveyor," a total of £162,065, or an average of $1,170 per mile. Essex County main roads total 788½ miles, though 116½ miles are under urban authority, making the length under the direct control of the county council 672 miles.

Some difficulty was experienced in the maintenance of the Essex roads owing to the lack of railway transportation for the conveyance of granite and the small quantity possible of delivery as compared with requirements. The railway strike of September, 1919, imposed an additional strain upon the roads at a time when they were least able to stand it. Several of the Essex roads suffered to such an extent that complete reconstruction will be necessary, one of such roads being the one from London to Ipswich, running through the center of the county. To restore this road alone, which is but 33 miles in length, an expenditure of £132,000 will be necessary, it is estimated, exclusive of the cost of repair to damaged bridges.

As an indication of the traffic carried by some of these roads during the railway strike, statistics taken in November, 1919, show that on one occasion, about 2 a. m., a fleet of 39 loaded trucks, representing 585 tons, passed an observation post on the Chelmsford-Colchester road at intervals of 45 seconds.

PENNSYLVANIA AUTOMOBILE REGISTRATIONS DURING 1920.

Figures made public recently by the State Highway Department of Pennsylvania show that a total of 1,069,603 1920 automobile licenses of all sorts have been issued. The figures show that there was an increase in almost all classes of registrations. Comparative tables are as follows:

COMPARISON OF AUTOMOBILE REGISTRATIONS IN 1919 AND 1920.

Registrations plates.	1920	1919
Passenger cars	507,622	429,001
Commercial vehicles	50,226	40,406
Tractors and traction engines	3,160	3,328
Trailers	839	1,291
Motor cycles	23,510	25,123
Motor vehicle dealers	13,761	9,935
Tractor dealers	231	188
Motor-cycle dealers	241	[1]
Bicycles with motor attached	1,128	[1]
Total	600,723	509,272
LICENSES ISSUED.		
Motor vehicle licenses, all kinds	600,723	509,272
Paid drivers	114,345	82,343
Licensed operators	128,291	146,282
Tractor drivers	368	[1]
Transfer of licenses	40,736	31,463
Special operators	466	[1]
Learners, permit	2,487	[1]
Vendee affidavits secondhand cars	180,653	16,344
Dealers in used motor vehicles	1,534	951
Total	1,069,603	786,590

[1] Classifications as required by new motor law after Jan. 1, 1920.

The decrease in the number of licensed operators is attributed to the fact that all owners of motor vehicles are now given an operator's license free of charge, while persons not owners pay a fee. Department officials are unable to explain the apparent decrease in the number of motor cycles during 1920. There is also a decrease in the number of traction engines and trailers.

The number of paid drivers' licenses kept step with the increase in the number of passenger and commercial vehicles.

That many automobiles change hands during the course of the year is evidenced by the large number of vendee affidavits relative to used cars, of which during the first nine months in 1920 there were 180,000.

The law compelling the filing of affidavits relative to secondhand cars was not in effect during all of 1919.

EDUCATIONAL CONFERENCE ON HIGHWAYS AND TRANSPORTATION.

IN spite of the enormous increase in the demand for better highways and motor vehicles caused by the recent rapid extension of motor transportation, it is claimed that the engineering schools of the country are annually furnishing only a small percentage of the number of trained men required by the industry. To supply this lack, the Commission on Highway and Highway Transport Education, which has been called together under the direction of P. P. Claxton, National Commissioner of Education, is formulating a plan to furnish the universities with facilities for putting into operation the recommendations of leading highway and transportation experts.

At the University of Pittsburg, where the commission has met twice to date, a study of automotive and highway problems has been a feature of the engineering course for several years. The university is among the first in the country to maintain a laboratory for the study of automotive engineering. More recently a new building, now virtually completed, has been constructed at the university which combines under one roof laboratories devoted to the study of automotive engineering and highway testing. This is a new departure in the field and is in line with the policies which the Commission on Highways and Highway Transportation Engineering Education hopes to promote.

It is believed that other universities will follow this lead, and that the shortage of trained engineers for the work will be eliminated quickly. The commission's plans, although still in the process of formation, will no doubt call for the incorporation of the study of the rules of the road and similar elementary transportation features into the curricula of high schools and grade schools. Courses of study will be planned for collegiate institutions and the plans include also the extension of the idea to vocational schools. All this, of course, is to be done for the better preparation of engineering students who are to undertake the nation's transportation problems, the solution of which is felt to be of as great importance to a rapidly growing industrial and commercial people as any in the country's history.

The members of the commission, in addition to Mr. Claxton, are Dean Bishop, of the University of Pittsburg; Roy D. Chapin, president of the Hudson Motor Car Co.; Walter C. John, specialist in land grant statistics of the Bureau of Education; T. H. MacDonald, chief of the Bureau of Roads; Paul D. Sargent, president of the American Association of Highway Officials; H. S. Firestone, of the Firestone Tire Co.; and C. J. Tilden, professor of Engineering Mechanics at Yale University.

BUREAU ASSISTS IN CAR ALLOCATION.

AFTER the issuance of Order No. 7 by the Interstate Commerce Commission providing for preferential treatment in the use of open-top car equipment for the movement of coal, a hearing was held by the commission beginning on July 8 and extending three days, at which representatives of the railroads, the coal interests, and the shippers of sand, gravel, and similar material were given an opportunity to state their support of or opposition to the order and the continuance of any policies of priorities or embargoes. At this hearing Mr. Daniel B. Willard, chairman of the Advisory Committee of Railway Executives, stated that in his judgment the railroads should endeavor to move road materials for maintenance purposes and for completion of important contracts under construction. He also stated that close working arrangements should be perfected between the shippers and railway officials for the purpose of obtaining all the benefits possible from close cooperation. This latter position was indorsed by Chairman Clark of the commission in his final statement of the conference. Later, in testifying before the Committee on Reconstruction and Production, of which Senator Calder is chairman, in New York on August 12, Mr. Willard again took a similar position that the railroads should endeavor to transport necessary material for the completion of important road projects which are now already begun. In order to accomplish these ends the Bureau of Public Roads has been working in close cooperation with the State highway departments and the Car Service Commission of the American Railroad Association. In cases where cars can not be secured for shipping materials needed for the completion of important road projects or for the maintenance of highways, through the ordinary channels, a plan is being followed by which applications for cars are forwarded to the Car Service Commission. The bureau is assisting the Car Service Commission in passing on these permits by furnishing information as to the importance and status of the road projects for which the applications for the movement of materials are made.

FEDERAL AID ALLOWANCES.

PROJECT STATEMENTS APPROVED IN JULY, 1920.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost.	Federal aid.
Alabama	75	Wilcox and Marengo	12.420	Gravel	July 9	$206,873.48	$103,436.74
	76	Sumter	17.386	do	July 14	304,223.68	152,111.84
Arizona	31	Maricopa		Bridge	July 9	50,006.00	25,003.00
	32	do		do	July 10	45,440.34	22,720.17
	33	do	6.751	Bitulithic or concrete	July 14	239,229.87	119,614.93
Arkansas	104	Faulkner	5.480	Macadam	July 15	60,360.30	21,000.00
	108	Benton	39.940	Gravel	do	130,634.57	58,800.00
	88	Pike	27.380	do	July 10	188,210.60	82,855.59
	85	Conway	11.430	Macadam	July 15	126,260.14	40,000.00
	102	Faulkner	6.860	do	July 14	76,644.37	25,000.00
	103	do	4.810	do	July 15	52,321.83	20,000.00
	63	White	11.010	Gravel	do	99,195.25	36,300.00
	71	Crittenden	7.520	Gravel macadam	July 9	94,043.40	35,000.00
	80	Arkansas	15.540	Macadam surface	July 15	355,267.11	63,750.00
	99	Mississippi	14.330	Gravel	July 9	147,966.50	50,000.00
	109	Baxter	6.820	Macadam surface	July 21	54,506.85	20,000.00
	84	Conway	1.270	Bituminous macadam	July 13	[1] 5,445.51	
	67	Dallas	2.060	Gravel	July 16	[1] 3,089.62	
California	60	Mono	13.410	Earth	July 13	161,678.00	80,839.00
	61	Butte		Bridge	July 9	462,000.00	231,000.00
Colorado	123	Garfield and Eagle	6.941	Earth	July 3	97,110.72	48,555.36
	106	Routt	1.354	Gravel	July 9	28,182.81	14,091.40
	80	do	6.629	Earth	July 12	58,197.86	29,098.93
	116	El Paso	4.439	Gravel	July 14	103,284.20	51,642.10
	47	do	1.855	do	July 21	39,053.85	19,526.92
	52	Teller	4.924	Earth	do	24,265.94	12,132.97
	75	Grand	7.000	do	July 16	25,553.16	12,776.58
	113	Chaffee	4.498	do	July 20	73,509.57	36,754.78
	128	Rio Blanco	3.000	Shale	July 21	18,332.60	9,166.30
	74	Moffatt	6.500	Gravel	July 27	73,691.34	36,845.67
	58	Powers	1.747	do	July 9	[2] 11,195.14	[2] 5,597.57
Georgia	138	Warren	9.000	Sand-clay	do	66,297.24	33,148.62
	140	Hancock	11.000	do	July 8	46,791.04	23,395.52
	160	Houston		Bridge	July 9	48,973.10	20,000.00
	164	Macon		do	do	27,024.80	12,000.00
	148	Baron	4.617	Sand-clay	do	68,623.50	25,000.00
	141	Richmond	12.000	do	do	47,041.96	23,520.98
	155	Elbert	8.000	do	do	60,060.00	30,000.00
	167	Fulton	2.500	Concrete	do	83,776.00	37,500.00
	173	Schley	2.500	Sand-clay	July 12	23,295.19	11,647.54
	134	Coweta	19.850	Topsoil	July 10	270,362.40	50,000.00
	139	Taliaferro	5.500	Sand-clay	July 9	31,307.79	12,000.00
	169	Clinch	8.000	Topsoil	July 10	33,654.50	15,000.00
	171	Calhoun		Bridge	July 12	41,063.00	15,000.00
	172	Baldwin		do	July 9	42,464.92	12,000.00
	116	Walton	7.130	Topsoil	July 10	59,314.98	29,657.49
	161	Richmond	2.600	Bridge	July 9	71,032.01	35,516.00
	163	Stewart	1.750	Sand-clay	July 10	33,262.13	12,500.00
	51	Colquitt	3.340	Paved	July 9	[1] 61,536.62	[1] 30,768.31
	102	Cobb	4.000	Pavement	July 22	[3] 79,817.65	[3] 39,908.82
	166	Dougherty	2.000	Paved	July 15	77,693.00	15,900.00
	168	Jefferson	10.000	Sand-clay	July 12	33,967.42	16,983.71
	175	Wilkinson	2.800	do	July 14	22,034.99	10,000.00
	176	Lincoln	5.000	do	July 15	29,149.78	12,000.00
	174	Campbell	2.000	Paved	July 20	63,227.45	27,500.00
	165	Polk	6.500	Sand-clay	July 14	42,450.65	14,225.32
	44	Hall	11.410	Topsoil	do	[2] 45,655.02	[2] 22,827.51
	106	Sumter	2.000	Bituminous surface	July 16	[2] 79,972.42	[2] 48,984.08
	69	Franklin	8.055	Topsoil	July 15	[1] 38,100.66	[1] 19,816.58
Idaho	30	Power	19.200	Gravel	July 6	159,863.00	79,931.50
	19	Bonner	16.700	Crushed rock	July 9	167,999.61	83,999.80
	49	Ada	1.500	Bituminous concrete	July 20	29,981.60	14,990.80
	48	Fremont	1.070	Gravel	July 28	45,445.84	17,000.00
Iowa	134	Worth	8.500	do	July 14	83,751.25	41,800.00
	32	Des Moines	2.070	Paved	July 9	[2] 198,619.85	
	51	Guthrie	2.670	Earth	July 15	[2] 100,340.90	
Kansas	60	Anderson	7.500	Gravel	July 9	268,290.00	75,500.00
	61	Lima	7.750	Macadam	do	230,263.00	75,000.00
	62	Morris	6.500	do	do	274,748.10	97,000.00
	64	Neosho	5.500	Gravel	do	120,254.75	60,127.37
	63	do	5.000	do	July 12	95,342.50	47,671.25
	59	Douglas	11.000	Concrete	July 10	439,120.00	165,000.00
	65	Allen	2.000	do	July 30	94,641.80	30,000.00
Kentucky	33	Boyd	1.100	Rock asphalt	July 12	25,599.20	12,799.60
	34	Webster	10.300	Earth	do	141,644.25	70,822.12
	31	Meade	13.830	do	July 17	160,215.00	80,107.50
	35	Boyd	16.140	Brick and bituminous surface	July 21	534,957.72	267,478.86
	36	Grant	3.980	Bituminous and concrete	July 30	142,303.76	71,151.85
Louisiana	50	Lafourche	10.350	Gravel	July 12	96,190.76	48,095.38
	55	Jefferson Davis	19.430	do	July 9	216,163.20	108,081.60
	68	Caddo	9.500	do	July 12	371,447.73	185,723.86
	30	Allen	10.240	Sand-clay or gravel	July 15	119,647.66	35,550.00
	74	Iberia	4.600	Gravel	July 21	67,090.65	33,545.32
	73	Richland	31.150	do	do	579,337.66	209,607.61
Massachusetts	40	Worcester	1.012	Concrete	July 6	40,491.00	20,240.00
	43	do	.625	do	July 9	65,202.50	12,500.00
	44	Hampshire	6.566	Bituminous macadam	do	327,827.50	159,700.00
	42	Berkshire	2.291	Macadam	do	104,720.00	45,820.00
	39	do	7.923	Bituminous macadam	July 13	294,390.80	147,195.40
	41	Middlesex	1.250	Gravel	do	24,944.70	12,472.35
Michigan	46	Charlevoix	11.000	do	July 12	209,990.00	104,995.00
Minnesota	198	Hennepin	1.420	Concrete	do	88,139.31	4,900.00
	186	do	3.800	Asphaltic	July 15	245,871.89	15,293.20
	187	Carlton	1.310	Gravel	do	12,624.70	6,312.35
	185	Jackson	6.000	Gravel	July 15	48,510.00	24,255.00
	103	Renville	10.820	Concrete, brick, asphaltic	July 7	[1] 49,419.92	[2] 5,023.30

[1] Revised project statements. Amounts given are decreases from those in the original statements.
[2] Revised project statement. Amounts given are increases from those in the original statements.
[3] Canceled or withdrawn.

PROJECT STATEMENTS APPROVED IN JULY, 1920—Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost	Federal aid.
Mississippi	31	Alcorn	3.250	Gravel	July 27	$52,635.00	$23,500.00
	98	Madison	9.800	Earth	...do	74,426.99	37,213.49
Missouri	124	Barry	5.500	Gravel	July 8	43,494.00	21,747.00
	89	Laclede	8.780	...do	...do	53,563.62	26,781.81
	121	Barry	9.900	Macadam	...do	67,711.20	33,855.60
	131	Pettis	10.800	...do	...do	140,400.00	70,200.00
	132	Henry	6.100	Gravel	July 9	60,023.99	30,011.99
	110	Phelps	15.700	...do	...do	83,057.72	41,528.86
	100	St. Clair	7.720	...do	July 15	38,600.00	19,300.00
	126	Audrain	3.800	...do	July 10	62,666.18	31,333.09
	129	Wayne	31.000	...do	July 12	110,979.00	55,489.50
	133	Henry	8.100	...do	...do	82,475.00	41,237.50
	134	Stone	7.210	...do	...do	18,355.32	9,177.66
	105	Iron	28.500	...do	July 10	243,633.15	121,816.57
	109	Texas	28.000	...do	...do	85,100.00	42,550.00
	128	Henry	8.000	Earth	...do	34,800.00	17,400.00
	103	Montgomery	13.000	...do	July 15	46,198.90	23,099.45
	107	Iron	13.000	Concrete and gravel	...do	116,205.63	58,102.81
	130	Harrison	22.200	Earth	...do	288,642.20	144,321.10
	101	Madison	24.680	Gravel	July 14	137,659.50	68,829.75
	111	Ozark	40.700	...do	July 21	80,840.00	40,420.00
	125	Daviess	8.880	Earth	July 14	139,664.83	69,832.41
	127	Henry	6.600	Chert	...do	105,600.00	52,800.00
	136	Callaway	1.000	Gravel	July 21	30,000.00	15,000.00
	144	...do	15.700	...do	July 20	70,343.73	35,171.86
	115	Dallas	16.300	...do	July 28	39,300.00	19,650.00
	140	...do	4.840	...do	...do	15,840.00	7,920.00
	92	Laclede	12.570	...do	July 30	63,577.80	31,788.90
	97	Callaway	18.000	Gravel and macadam	...do	146,800.00	73,400.00
	112	Dallas	8.300	Gravel	July 28	28,293.20	14,146.60
	119	Miller	18.750	...do	...do	136,824.49	68,412.24
	143	Morgan	20.000	...do	July 30	68,139.99	43,069.99
	145	Barry	4.000	...do	...do	15,999.99	7,999.99
	150	Green	31.500	Macadam and gravel	...do	157,500.00	78,750.00
	151	Barry	4.500	...do	...do	22,400.00	11,200.00
Montana	94	Meagher	14.000	Earth	July 12	96,514.34	48,257.17
	98	Flathead	4.000	Gravel or rock	July 10	19,974.68	9,987.34
	123	Stillwater	8.300	Gravel	July 13	55,526.39	27,763.19
	129	...do	1.162	...do	July 9	19,656.03	9,828.01
	90	Sanders	8.000	...do	July 15	43,975.20	21,987.60
	96	Pondera	22.390	...do	...do	198,779.67	99,389.83
	115	Wheatland	10.000	...do	July 9	69,740.00	34,870.00
	99	Flathead	4.500	...do	July 15	19,904.50	9,952.25
	114	Rosebud	10.950	...do	...do	54,430.49	27,215.24
	121	Dawson	.456	Concrete	July 14	55,639.16	8,837.95
	125	Sweet Grass		Bridge	July 15	15,997.30	7,998.65
	78	Granite	11.500	Gravel	July 20	75,942.35	37,971.10
	88	Sanders	4.250	...do	July 14	39,633.47	19,816.73
	131	Missoula	7.000	...do	July 21	91,850.00	45,925.00
	133	Sweet Grass	5.980	...do	...do	49,440.16	24,720.08
	108	Musselshell	18.000	Topsoil	July 27	100,442.10	50,221.05
	2	Wibaux	2.220	Gravel	July 9	[1] 26,246.22	[1] 13,123.11
	46	Jefferson	3.500	Earth	July 6	[2] 22,000.00	[2] 11,000.00
	97	Broadwater	2.980	Gravel	July 15	[1] 11,824.26	[1] 5,912.11
	132	Hill	20.000	...do	July 28	101,283.60	50,641.80
	118	Lincoln	4.000	Earth	July 30	19,998.00	9,999.00
Nebraska	143	York, Fillmore, and Polk	39.300	...do	July 15	150,579.00	75,289.50
	157	Butler and Seward	24.800	...do	...do	95,964.00	47,982.00
	151	Lancaster	.596	Brick	July 14	41,420.50	10,474.55
	155	Lancaster and Sanders	13.300	Earth	...do	60,643.00	30,321.50
	153	Cass	34.000	...do	...do	130,020.00	65,010.00
	159	Fillmore	6.900	...do	July 16	26,807.00	13,403.50
	160	Brown	15.000	Sand-clay	...do	92,224.00	46,112.00
	161	Saline	17.600	Earth	July 21	79,706.00	39,853.00
	163	Keyapaha	9.000	Sand-clay	July 16	54,694.20	27,347.10
	44	Sherman	3.500	Earth	July 31	[3] 8,085.00	[2] 4,042.50
	59	Wheeler	8.000	Earth and sand-clay	...do	[2] 42,398.40	[2] 21,199.20
	61	Blaine	9.400	...do	...do	[2] 46,750.00	[2] 23,375.00
	62	Thomas	4.800	...do	...do	[3] 22,330.00	[2] 11,165.00
	80	Grant	13.200	...do	...do	[2] 44,105.60	[2] 22,052.80
	99	Thomas	14.800	...do	July 13	[2] 59,778.40	[2] 29,889.20
Nevada	28	Douglas	1.170	Concrete	July 28	51,739.93	23,400.00
New Hampshire	123	Hillsborough	.280	Gravel	July 12	8,000.00	4,000.00
	93	Belknap	.375	Macadam	July 9	12,600.00	6,300.00
	111	Carroll	3.040	Gravel	...do	42,000.00	21,000.00
	116	...do	.937	...do	July 13	11,999.99	5,999.99
	120	...do	6.600	...do	July 10	80,000.00	40,000.00
	122	Cheshire		Bridge	...do	17,000.00	8,500.00
	119	...do	.448	Bituminous macadam	July 12	15,000.00	7,500.00
	124	Belknap	1.260	...do	July 15	18,035.67	9,017.83
	121	Sullivan	1.140	Gravel	...do	20,000.00	10,000.00
New Mexico	51	Socorro	10.500	...do	July 28	52,514.00	26,257.00
	52	...do	11.300	Rock	...do	70,466.00	35,233.00
New York	71	Fulton	3.500	Bituminous	July 15	140,000.00	70,000.00
	68	Otsego	2.820	Concrete	July 14	147,000.00	51,450.00
	73	Madison and Oneida	10.480	Reinforced concrete	...do	545,300.00	190,855.00
	25	...do	5.700	Concrete	July 3	[2] 151,470.00	[2] 75,735.00
	10	Rockland	2.470	Bituminous macadam or concrete	May 28	[2] 49,399.35	[2] 24,699.67
	20	Delaware	5.100	Bituminous macadam	...do	[2] 118,400.00	[2] 59,200.00
	21	Rockland	1.450	Concrete	...do	[2] 52,200.00	[2] 26,100.00
	42	Delaware	5.750	...do	...do	[2] 230,000.00	[2] 115,000.00
North Carolina	129	Richmond	16.700	Sand-clay	July 15	105,985.00	52,992.50
	78	Rutherford	36.000	Topsoil and gravel	July 17	91,790.60	45,895.30
	38	Caswell	6.800	Topsoil	July 21	[1] 68,053.45	[1] 5,563.64
	124	Surry	18.000	...do	July 27	[2] 141,644.80	[2] 70,822.40
	140	Robeson	38.500	Sand-clay	...do	[2] 312,950.00	[2] 156,475.00
North Dakota	107	Grand Forks	6.000	Gravel	July 6	38,541.53	19,270.76
	106	Pierce	7.375	Earth	July 12	30,250.00	15,125.00
	108	Griggs	17.000	...do	July 30	84,370.00	42,185.00
	109	...do	16.000	...do	...do	72,170.00	36,355.00

[1] Revised project statements. Amounts given are increases from those in the original statements. [2] Canceled or withdrawn.

PROJECT STATEMENTS APPROVED IN JULY, 1920—Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost	Federal aid.
Ohio	117	Cranford	4.080	Brick or asphalt	July 12	$219,000.00	$50,000.00
	151	Clermont	5.489	Macadam	...do	189,700.00	88,000.00
	140	Huron	3.110	Brick	July 9	132,600.00	28,700.00
	166	Brown	3.240	Waterbound macadam	...do	89,000.00	33,000.00
	168	Highland	2.240	Macadam	July 15	88,300.00	14,000.00
	130	Montgomery	3.250	Kentucky rock asphalt	July 12	137,000.00	38,000.00
	152	Coshocton	4.043	Monolith brick or concrete	...do	192,000.00	57,000.00
	163	Richland	3.301	Concrete or bituminous macadam	...do	169,000.00	33,000.00
Oklahoma	33	Choctaw	57.000	Crushed lime rock	...do	660,385.70	330,192.85
	41	Bryan	56.000	Crushed rock	...do	900,000.00	450,000.00
	29	Cotton	2.153	Concrete	July 9	185,366.00	43,053.00
	35	Adair	8.000	Gravel	...do	36,334.20	18,167.10
	36	Latimer	3.000	Burnt shale	July 12	40,000.00	20,000.00
	47	Johnston	20.000	Gravel	July 13	249,816.60	124,908.30
	34	Ottawa	2.500	...do	...do	40,150.00	20,055.00
	19	Oklahoma	13.500	Paved	July 15	540,000.00	270,000.30
	37	Atoka	1.000	Gravel	July 14	16,000.00	8,000.00
	32	Wagoner	18.500	...do	July 20	233,600.00	116,800.00
Oregon	46	Malheur	0.891	Bituminous or concrete	July 12	27,066.60	13,533.30
	41	Gilliam	6.900	Broken stone or gravel	July 10	171,132.50	85,566.25
South Carolina	38	Oconee	18.367	Topsoil	July 8	200,056.88	56,179.54
	77	York	1.544	Concrete	...do	68,282.50	10,000.00
	61	Darlington	19.676	Sand-clay	...do	144,530.17	50,000.00
	68	Chester	9.147	Topsoil	July 15	73,341.59	35,000.00
	80	Williamsburg	11.027	Sand-clay	...do	113,703.11	56,851.55
	96	Anderson	8.550	Concrete and topsoil	July 9	115,926.69	57,963.34
	69	Chester	6.137	Topsoil	July 12	95,405.13	25,000.00
	71	York	6.520	...do	July 10	45,343.83	14,000.00
	92	Union	6.227	...do	July 15	32,921.57	7,414.19
South Dakota	56	Sully	13.100	Gravel	July 12	74,662.28	37,331.04
	54	Grant	6.000	...do	...do	46,623.50	23,311.75
	61	Brule and Aurora	12.800	Earth	...do	63,316.00	31,658.00
	63	McPherson	16.450	...do	...do	79,321.00	39,660.50
	59	Fall River	5.530	Gravel	July 21	91,722.40	45,861.20
	60	Pennington	9.400	...do	...do	76,472.00	38,236.00
	11	Union	9.040	Gravel	July 20	[3] 41,283.00	[3] 16,412.70
Tennessee	20	Fentress	14.322	Macadam	July 8	273,221.44	136,610.72
	22	Weakley and Carroll	14.540	Bituminous macadam	July 12	481,498.54	240,749.27
	47	Rutherford	16.300	...do	July 13	420,524.64	210,262.32
	50	Lincoln	15.284	...do	...do	642,253.51	321,126.30
	46	Dickson	9.940	Waterbond macadam	July 14	195,300.78	96,719.51
Texas	179	Ellis	11.500	Crushed stone	July 12	208,530.30	75,000.00
	165	Webb	30.000	Gravel	...do	258,797.86	88,492.88
	166	Atascosa	13.470	...do	July 10	285,733.22	142,866.61
	168	Robertson	18.000	...do	July 12	141,626.65	69,262.00
	169	Dickens	7.540	...do	July 9	36,040.34	18,020.17
	170	Fort Bend	13.170	Bituminous	July 12	248,654.94	50,000.00
	171	Hunt	11.140	Macadam	July 10	305,967.24	76,491.81
	174	Randall	17.100	Earth	...do	28,191.43	14,000.00
	175	Matagorda	10.100	Shell	July 12	53,290.02	26,634.22
	176	Runnels	5.700	Gravel	July 9	44,234.91	22,117.45
	192	Harrison	24.560	...do	July 15	205,750.60	100,000.00
	172	Lamar	4.850	...do	July 9	167,160.08	83,580.04
	150	Jasper		Bridge	July 15	59,996.11	25,000.00
	183	Gonzales	28.200	Gravel	...do	278,219.89	113,750.00
	158	Hemphill	14,440	Sand clay	...do	79,931.98	39,965.99
	177	Hays	17.050	Crushed stone	...do	64,682.11	30,000.00
	188	Hunt	10.790	Gravel, surface treated	...do	298,430.46	106,914.23
	134	Polk	17.930	Bituminous	July 13	[1] 100,618.39	[1] 25,154.60
	189	Hunt	8.690	Bituminous surface	July 15	205,498.37	68,499.46
	190	...do	3.460	...do	...do	120,237.17	48,094.87
	182	Taylor		Bridge	July 14	66,139.70	33,069.85
	173	Travis	6.100	Gravel, bituminous surface	July 27	74,214.95	37,107.47
	184	Falls	0.768	Gravel	July 15	16,504.80	8,252.40
	181	Johnson	13.000	...do	July 28	276,159.40	100,000.00
	195	Falls	7.000	Gravel, bituminous surface	...do	148,819.00	70,000.00
	180	San Patricio	27.557	Gravel	July 30	349,392.79	174,696.39
	187	Bastrop	27,293	...do	...do	191,078.60	95,539.30
Utah	93	Cameron	14.721	Concrete	July 21	[2] 417,415.51	[2] 233,333.33
Vermont	14	Boxelder	0.404	Paved	July 10	9,357.37	4,678.68
Virginia	17	Windsor		Bridge	...do	10,730.50	5,365.25
	64	Norfolk and Nansemond	8.000	Concrete	July 12	319,352.00	159,676.00
	83	Pittsylvania	2.990	Bituminous macadam	July 16	80,865.40	40,432.70
Washington	59	Snohomish		Bridge	July 8	23,622.50	11,811.25
	75	Okanogan	4.140	Gravel	...do	29,994.36	14,997.18
	73	Pacific	7.630	Earth	July 15	279,974.64	138,000.00
	74	Skagit		Bridge	...do	19,800.00	9,900.00
	65	Okanogan	1.990	Gravel	July 21	35,841.19	15,000.00
	76	Pierce	0.500	...do	...do	34,667.60	12,750.00
West Virginia	98	Randolph	4.500	Macadam	July 13	88,281.60	39,040.00
Wisconsin	120	Trempealeau	7.150	Gravel	July 9	125,802.79	46,548.54
	134	Juneau	5.280	Topsoil	...do	41,864.69	18,000.00
	166	Langlade	7.570	Earth	...do	36,667.51	15,500.00
	114	Oconto	4.880	Gravel	July 10	45,915.98	17,000.00
	105	Monroe	3.750	Shale	July 13	36,230.73	11,700.00
	179	Waukesha	5.860	Concrete	July 14	275,082.58	77,000.00
	125	Taylor	4.510	Earth	July 27	41,941.36	15,000.00
	176	Sauk	1.310	Gravel	July 30	22,056.30	9,378.00
Wyoming	80	Hot Springs		Bridge	July 13	89,100.00	44,550.00
	91	Platte	15.100	Select material	July 19	137,720.00	68,860.00
	90	Hot Springs	3.228	...do	July 14	37,785.00	18,892.50
	94	Park		Bridge	July 22	14,630.00	7,315.00
	72	Big Horn	0.664	Select material	July 28	22,110.00	11,055.00
	97	Sweetwater	1.818	Earth	July 27	12,760.00	6,380.00

[1] Revised project statements. Amounts given are decreases from those in the original statements.
[2] Revised project statements. Amounts given are increases from those in the original statements.
[3] Canceled or withdrawn.

PROJECT AGREEMENTS EXECUTED IN JULY, 1920.

State.	Project No.	County.	Length in miles.	Type of construction.	Project agreement signed.	Estimated cost.	Federal aid.
Colorado	68	Rio Grande	11.358	Gravel	June 30	$84,459.47	$42,229.73
Georgia	91	Lowndes	4.920	Paving	July 9	170,437.45	85,218.72
Illinois	1–20	Whiteside	2.072	Concrete	July 2	80,737.96	40,368.98
	7LU	La Salle	4.134	Earth	...do	140,602.98	69,541.65
	10EFG	Will	21.072	Concrete	...do	824,246.56	405,026.37
	11R	Vermillion	4.848	Concrete and brick	...do	103,536.84	51,768.42
	5EM	Peoria and Marshall		Concrete	...do	[1] 128,446.23	[1] 59,680.88
	5 (BC) D (G–15–d)	...do		...do	...do	[1] 184,701.42	[1] 81,660.00
	1–14	Whiteside		...do	...do	[1] 6,188.76	[1] 3,094.38
	1–15	...do		...do	...do	[1] 16,309.40	[1] 8,154.70
	1–10, 11,16	...do		...do	...do	[1] 31,789.78	[1] 15,894.88
Kansas	40GHI	Crawford	2.981	Mono brick or concrete	July 8	242,460.37	44,722.50
Maine	7	Aroostook	3.500	Gravel	July 13	84,099.95	42,049.97
	24	...do	3.310	...do	...do	68,871.33	34,435.66
Michigan	43AB	Muskegon	13.956	Concrete	July 9	574,433.34	284,744.85
	3	Baraga		Earth	July 12	[1] 265,879.12	[1] 116,512.44
Minnesota	86	Aitkin	10.480	Gravel	July 30	57,030.05	25,000.00
Mississippi	81	Bolivar	4.470	Concrete	June 30	80,303.16	40,151.58
	80	Adams		Gravel	...do	[1] 2,576.62	[1] 1,288.31
Missouri	38	Lewis	8.371	...do	July 13	133,317.15	66,658.57
Nebraska	49A	Thurston and Dakota	11.243	Earth	July 31	101,063.10	50,531.55
	82A	Garden	8.670	Sand-clay	...do	100,802.39	50,401.19
	84A	Greeley	6.603	...do	July 30	47,658.66	23,829.33
	87A & B	Madison	11.140	Gravel	...do	49,186.77	24,593.38
	88B	Dodge and Cuming	1.011	Sand gumbo	July 31	9,800.95	4,900.47
	107A	Cass, Lancaster, Saunders	8.230	Earth	...do	45,379.77	22,689.88
	123	Richardson	1.477	Sand-clay	July 30	69,744.07	34,872.03
	130A	Cheyenne	12.040	Earth	...do	72,051.85	36,025.92
	112	Douglas	16.690	...do	July 31	86,941.97	43,470.98
	55A	Saline	1.050	...do	July 30	9,804.13	4,902.06
	64A	Pierce	9.608	...do	...do	64,305.50	32,152.75
	76A	Dawes	14.530	...do	...do	115,253.64	57,626.82
	17	Lancaster		...do	...do	[1] 21,697.52	[1] 5,022.66
	34A	Garfield		Sand-clay	...do	[1] 11,054.58	[1] 5,527.29
	35A	Douglas		Earth	...do	[1] 3,126.83	[1] 1,563.41
	66	Cherry		Sand-clay	July 31	[1] 5,745.08	[1] 2,872.54
	71	Franklin	3.130	Earth	...do	[2] 35,673.89	[2] 17,836.94
	98	Saline and Lancaster		...do	July 30	[1] 1,502.14	[1] 751.07
	115	Platte	0.797	Concrete	July 31	[2] 40,707.63	[2] 15,940.00
North Carolina	13	Wayne	12.573	Topsoil	July 29	101,467.96	50,733.98
	57	Rowan	7.205	Topsoil and concrete or other hard surface.	...do	77,168.57	38,584.28
	59A	Columbia	11.025	Topsoil	...do	88,464.64	44,232.32
	62	Buncombe	3.430	Bituminous macadam	...do	139,191.32	69,595.66
	61A	Brunswick, New Hanover	2.179	Concrete	...do	118,690.00	43,580.00
	67A	Nash		Asphalt or concrete	July 31	[1] 9,803.86	[1] 4,901.93
	92	Surry		Topsoil	...do	[1] 27,118.41	[1] 13,559.20
	91	...do		...do	July 29	[2] 12,190.84	[2] 6,095.42
	76	Cabarrus		Concrete	...do	[1] 5,950.56	[1] 2,683.40
	19	Rockingham		Topsoil	July 31	[1] 4,956.96	[1] 6,785.50
	44	Granville		...do	July 29	[1] 5,863.80	[1] 10,188.71
	47	Guilford		Bituminous surface	...do	[1] 21,584.12	[1] 10,792.06
	50	...do		...do	July 31	[1] 19,109.37	[1] 9,554.69
	51	...do		Bituminous concrete	July 29	[1] 20,801.20	[1] 10,400.60
	54	Wake		Warrenite	...do	[1] 15,438.95	[1] 7,719.48
	55A	Mecklenburg		Bituminous concrete or cement and macadam base.	...do	[1] 60,325.57	[1] 30,162.78
	29	Union		Topsoil	...do	[1] 9,413.91	[1] 4,706.95
	63	Buncombe	0.073	Penetration macadam	July 31	[1] 34,388.23	[1] 11,424.05
	67B	Nash	0.006	Topeka or concrete	...do	[1] 13,160.67	[1] 3,344.45
	74A	Stanly		Topsoil	...do	[1] 535.15	[1] 267.57
	39	Union		Topsoil and bituminous macadam	...do	[1] 34,872.09	[1] 17,436.05
	72A	Anson	3.896	Topsoil	July 29	70,470.89	35,235.44
	77	Rutherford	2.206	Concrete	...do	100,159.44	44,120.00
	80A	Montgomery	16.528	Topsoil	July 31	185,823.02	92,911.51
	94A	Mitchell	5.036	Rock asphalt	July 29	131,796.39	65,898.19
	109	Burke	3.584	Topsoil	...do	55,191.64	27,595.82
	111	Forsyth	12.086	...do	...do	65,278.45	32,639.22
	74B	Stanly	4.919	...do	July 31	63,411.26	31,705.63
Oklahoma	15	Washington	12.780	Concrete	July 9	500,000.00	250,000.00
	21	Mackintosh	21.787	Concrete and gravel	...do	482,376.86	232,705.03
	22	Comanche	5.950	Gravel	...do	75,561.92	37,780.96
	24	Garfield	7.164	Bituminous concrete	...do	368,205.19	168,416.48
	25	Kingfisher	1.357	Concrete	...do	56,774.32	27,140.00
	27	Kay	1.712	...do	...do	68,600.31	34,235.79
South Carolina	41	Hampton	15.625	Sand-clay	July 8	134,313.93	44,817.39
	53	Charleston and Colleton		Bridge	...do	69,740.83	34,870.41
	36	Chesterfield	11.346	Sand-clay and topsoil	June 30	81,511.98	24,000.00
	48	Georgetown	16.849	Sand-clay	June 29	146,148.36	73,074.18
Utah	6	Grand and San Juan		Earth	July 6	[1] 159,305.16	[1] 79,652.58
Virginia	40	Dinwiddie		Concrete	May 18	[1] 1,576.69	[1] 788.34
West Virginia	70	Grant	8.630	Earth and water-bound macadam	July 28	59,900.00	29,950.00
	93	Monongalia	2.120	Reinforced concrete	July 30	102,829.03	31,120.00
	36	Upshur	3.080	Concrete	...do	118,036.00	45,845.00
	55	Tyler	1.184	Bituminous macadam	...do	36,000.00	18,000.00
	75A & B	Calhoun	4.470	Earth	...do	62,564.00	31,282.00
	81	Taylor	1.553	Concrete	...do	62,080.00	31,040.00
	83	Lewis	2.000	Brick on concrete base	...do	122,000.00	40,000.00
	87	Mason	4.400	Gravel	...do	57,955.38	28,520.00
	88	Wayne	2.600	Earth	...do	55,773.85	25,770.00
	91	Barbour	2.000	Bituminous macadam	...do	55,680.00	27,840.00
	94	Fayette	5.200	...do	...do	74,565.00	33,480.00
	96	Nicholas	2.210	Earth	...do	49,000.00	24,500.00
	21	Lewis		Brick	...do	[1] 1,321.20	[1] 3,670.00
	24	Preston		Bituminous macadam	...do		[1] 8,000.00
	25	Lincoln		Concrete	...do	[1] 47,440.99	[1] 17,954.34
	47	Wetzel		...do	...do	[1] 53,930.00	[1] 26,965.00
Wyoming	52	Fremont		Topsoil	July 9	37,654.76	18,827.38

[1] Modified agreements. Amounts given are increases over those in the original agreements.
[2] Modified agreements. Amounts given are decreases from those in the original agreements.

ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS.

Applicants are urgently requested to ask only for those publications in which they are particularly interested. The Department can not undertake to supply complete sets, nor to send free more than one copy of any publication to any one person. The editions of some of the publications are necessarily limited, and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, this city, who has them for sale at a nominal price, under the law of January 12, 1895. Those publications in this list, the Department supply of which is exhausted, can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free.

REPORTS.

*Report of the Director of the Office of Public Roads for 1916. 5c.
*Report of the Director of the Office of Public Roads for 1917. 5c.
Report of the Director of the Bureau of Public Roads for 1918.
Report of the Chief of the Bureau of Public Roads for 1919.

DEPARTMENT BULLETINS.

Dept. Bul. 105. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913.
136. Highway Bonds.
220. Road Models.
230. Oil Mixed Portland Cement Concrete.
*249. Portland Cement Concrete Pavements for Country Roads. 15c.
257. Progress Report of Experiments in Dust Prevention and Road Preservation, 1914.
314. Methods for the Examination of Bituminous Road Materials.
347. Methods for the Determination of the Physical Properties of Road-Building Rock.
*348. Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials. 10c.
370. The Results of Physical Tests of Road-Building Rock.
373. Brick Roads.
386. Public Road Mileage and Revenues in the Middle Atlantic States, 1914.
387. Public Road Mileage and Revenues in the Southern States, 1914.
388. Public Road Mileage and Revenues in the New England States, 1914.
389. Public Road Mileage and Revenues in the Central, Mountain, and Pacific States, 1914.
390. Public Road Mileage in the United States, 1914. A Summary.
393. Economic Surveys of County Highway Improvement.
407. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1915.
414. Convict Labor for Road Work.
*463. Earth, Sand-Clay, and Gravel Roads. 15c.
532. The Expansion and Contraction of Concrete and Concrete Roads.
537. The Results of Physical Tests of Road-Building Rock in 1916, including all Compression Tests.
555. Standard Forms for Specifications, Tests, Reports, and Methods of Sampling for Road Materials.
583. Reports on Experimental Convict Road Camp, Fulton County, Ga.
586. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1916.
660. Highway Cost Keeping.
670. The Results of Physical Tests of Road-Building Rock in 1916 and 1917.
691. Typical Specifications for Bituminous Road Materials.
704. Typical Specifications for Nonbituminous Road Materials.
724. Drainage Methods and Foundations for County Roads.
Public Roads, Vol. I, No. 11. Tests of Road-Building Rock in 1918.

OFFICE OF PUBLIC ROADS BULLETINS.

Bul. *37. Examination and classification of Rocks for Road Building, including Physical Properties of Rocks with Reference to Their Mineral Composition and Structure. (1911.) 15c.
*43. Highway Bridges and Culverts. (1912.) 15c.
*45. Data for Use in Designing Culverts and Short-span Bridges. (1913.) 15c.

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OFFICE OF PUBLIC ROADS CIRCULARS.

Cir. 89. Progress Report of Experiments with Dust Preventatives, 1907.
*90. Progress Report of Experiments in Dust Prevention, Road Preservation, and Road Construction, 1908. 5c.
*92. Progress Report of Experiments in Dust Prevention and Road Preservation, 1909. 5c.
*94. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1910. 5c.
98. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1911.
*99. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1912. 5c.
*100. Typical Specifications for Fabrication and Erection of Steel Highway Bridges. (1913.) 5c.

OFFICE OF THE SECRETARY CIRCULARS.

Sec. Cir. 49. Motor Vehicle Registrations and Revenues, 1914.
52. State Highway Mileage and Expenditures to January 1, 1915.
59. Automobile Registrations, Licenses, and Revenues in the United States, 1915.
63. State Highway Mileage and Expenditures to January 1, 1916.
65. Rules and Regulations of the Secretary of Agriculture for Carrying out the Federal Aid Road Act.
72. Width of Wagon Tires Recommended for Loads of Varying Magnitude on Earth and Gravel Roads.
73. Automobile Registrations, Licenses, and Revenues in the United States, 1916.
74. State Highway Mileage and Expenditures for the Calendar Year 1916.
77. Experimental Roads in the Vicinity of Washington, D. C.
Public Roads Vol. I, No. 1. Automobile Registrations, Licenses, and Revenues in the United States, 1917.
Vol. I, No. 3. State Highway Mileage and Expenditures in the United States, 1917.
Vol. I, No. 11. Automobile Registrations, Licenses, and Revenues in the United States, 1918.
Vol. II, No. 15. State Highway Mileage and Expenditures in the United States, 1918.

DEPARTMENT CIRCULAR.

No. 94. TNT as a Blasting Explosive.

FARMERS' BULLETINS.

F. B. 338. Macadam Roads
*505. Benefits of Improved Roads. 5c.
597. The Road Drag.

SEPARATE REPRINTS FROM THE YEARBOOK.

Y. B. Sep. *638. State Management of Public Roads; Its Development and Trend. 5c.
727. Design of Public Roads.
739. Federal Aid to Highways, 1917.

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH.

Vol. 5, No. 17, D–2. Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements.
Vol. 5, No. 19, D–3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
Vol. 5, No. 20, D–4. Apparatus for Measuring the Wear of Concrete Roads.
Vol. 5, No. 24, D–6. A New Penetration Needle for Use in Testing Bituminous Materials.
Vol. 6, No. 6, D–8. Tests of Three Large-Sized Reinforced-Concrete Slabs under Concentrated Loading.
Vol. 10, No. 5, D–12. Influence of Grading on the Value of Fine Aggregate Used in Portland Cement Concrete Road Construction.
Vol. 10, No. 7, D–13. Toughness of Bituminous Aggregates.
Vol. 11, No. 10, D–15. Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.
Vol. 17, No. 4, D–16. Ultra-Microscopic Examination of Disperse Colloids Present in Bituminous Road Materials.

* Department supply exhausted.